Level-1 Product Generation System (LPGS) Preliminary Design Walkthrough

April 18, 1997

LPGS Preliminary Design Walkthrough

Agenda

• **Opening Comments**	**R. Schweiss**
• **System Overview**	**R. Hamilton**
• **Operations Concept Overview**	**A. Bernard**
• **LPGS Software Subsystem Design**	
– **Overall Design Philosophy**	**B. Pedersen**
– **Process Control Subsystem**	**B. Pedersen**
– **Radiometric & Geometric Proc Subsystems**	**B. Pedersen**
– **Data Management Subsystem**	**S. Beckwell**
– **Quality Assessment Subsystem**	**S. Kraft**
– **Anomaly Analysis Subsystem**	**B. Nair**
– **End-to-End Scenario**	**B. Pedersen**
• **Size Estimate**	**D. Derrick**
• **Road to CDR**	**D. Derrick**
• **Closing Comments**	**R. Schweiss**

LPGS Preliminary Design Walkthrough

Opening Comments

- **Purpose of this Walkthrough**
- **Key Events**
- **Document Status**

LPGS Preliminary Design Walkthrough

Purpose of this Walkthrough

Purpose of this Walkthrough is:

- **to present work accomplished to date**
- **to solicit feedback and comments**
- **to establish an internal LPGS baseline for continuation of the LPGS design**

This Walkthrough is not:

- **a formal CCB Review**
- **CCB approval/baseline will be established at the formal review scheduled for August 1997**

RIDS are not part of today's process.

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Key Events

- **Project Approval Review** **05/17/96**
- **SRR/SDR** **12/10/96**
  - **22 RIDs were received and are closed**
- **LPGS master schedule modified** **03/19/97**
  - **CDR August 19, 1997 (TBD)**
  - **Release 1 System Testing ends: April 20, 1998**
  - **Release 2 System Testing ends: July 20, 1998**
  - **Release 3 TBD**
- **PDW** **04/18/97**
- **CDR** **8/TBD/97**

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Document Status

• Status of LPGS PDW Documents	Review	Final
– IAS/LPGS ICD:	5/97	8/97
– ECS/LPGS ICD:	5/97	8/97
– Preliminary Design Specification (PDS)	5/97	5/97
– Detailed Design Specification (DDS)	7/97	8/97
– Interface Definitions Document (IDD):	5/97	8/97
– DFCB, Volume 5:	5/97	8/97

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SYSTEM OVERVIEW

- System Design Drivers
- High Level Requirements
- Changes since SRR/SDR
- System Concept
- External Interfaces
- Revised Architecture
- Performance Analysis

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SYSTEM DESIGN DRIVERS

- **Reuse IAS elements to minimize new development and duplication**
- **Both Radiometric and Geometric processing subsystems to be intergrated and tested as Black Boxes**
- **Must output 25 scenes per day**
- **Must interface with ECS and IAS**

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HIGH LEVEL REQUIREMENTS (1 of 2)

- Generate 25 WRS scenes per day to Level 1 Systematic Correction(L1G)
- Provide Quality Assessment and Visual Display of products
- Support user selectable processing options:
  - Map Projection(7)
  - Orientation
  - Resampling Method(CC,NN & MTF)
  - Grid Cell Size
  - Band Selection
  - Product Choice

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HIGH LEVEL REQUIREMENTS (2 of 2)

- Provide Off-line analysis of image processing problems
- Process partial subintervals up to 3 WRS scene equivalents
- Interface with the ECS to receive product requests and LOR data
- Interface with ECS to deliver L1 data and processing status
- Provide capability to compensate for image artifacts:
  - Banding, Striping, Coherent Noise, Memory Effect, Scan Correlated Shift and Inoperable Detectors
- Support 3 output formats
  - HDF, GeoTIFF, and FAST

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CHANGES SINCE SRR/SDR (1 of 3)

- **LPGS to perform quality assessment after Level 1 product reformatting (RID #6)**
- **LPGS to package the MSCD, PCD and Calibration data in the final product versus ECS (RID #8)**
- **Provide an option for user to select Internal Calibrator or Calibration Parameter data for processing (RID #9)**
- **LPGS to select a consensus PCD and MSCD to include in the final product(RID #10)**
- **Delete requirement to handle Trouble Tickets from ECS (Under analysis CCR#?)**

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CHANGES SINCE SRR/SDR(2 of 3)

- **Corrected listing of image artifacts that LPGS will detect and characterize (deleted Scan Correlated Shifts and Memory Effect) (RID #14)**
- **Clarified that LPGS will be able to optionally print a color hard copy of the display of any band(RID #15-7)**
- **Modified requirement to hold all output products for 72 hours after retrieval by ECS - to- provide temporary storage for the equivalent of 3 days (75 WRS scenes plus associated files) of completed products. (This modification is to clarify the operations concept that once ECS pulls the product to their server and verifies the receipt the product can be deleted from LPGS servers.)**

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CHANGES SINCE SRR/SDR(3 of 3)

- **Modified system availability requirement from .95 to .96 and MTTR from 16 hours to 4 hours to align with other ground support systems (i.e., LPS). (RID #19)**
- **Added a requirement to control system aborts in a manner where the operator would retain system recovery features(RID# 21)**

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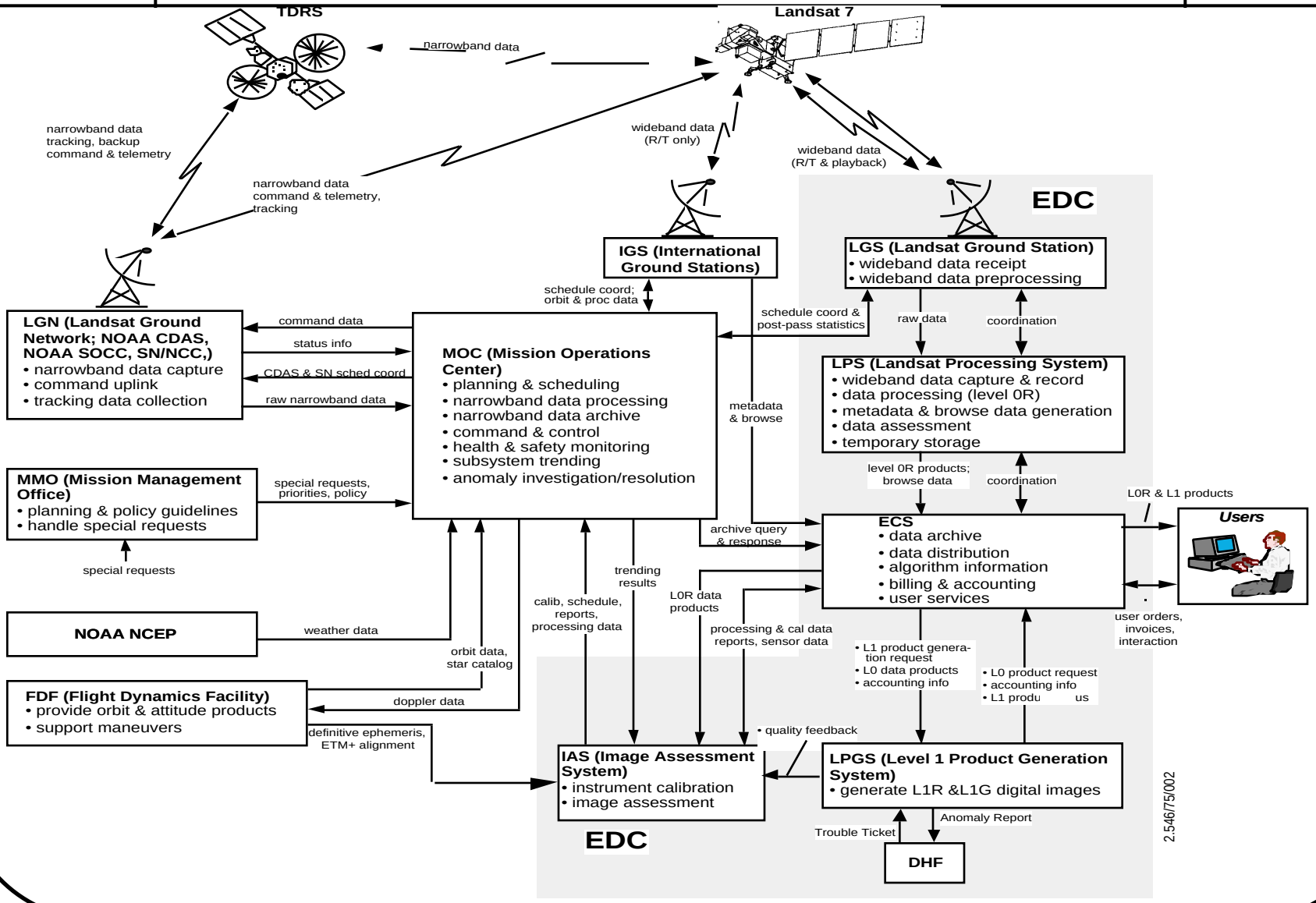
L7 Ground System Overview



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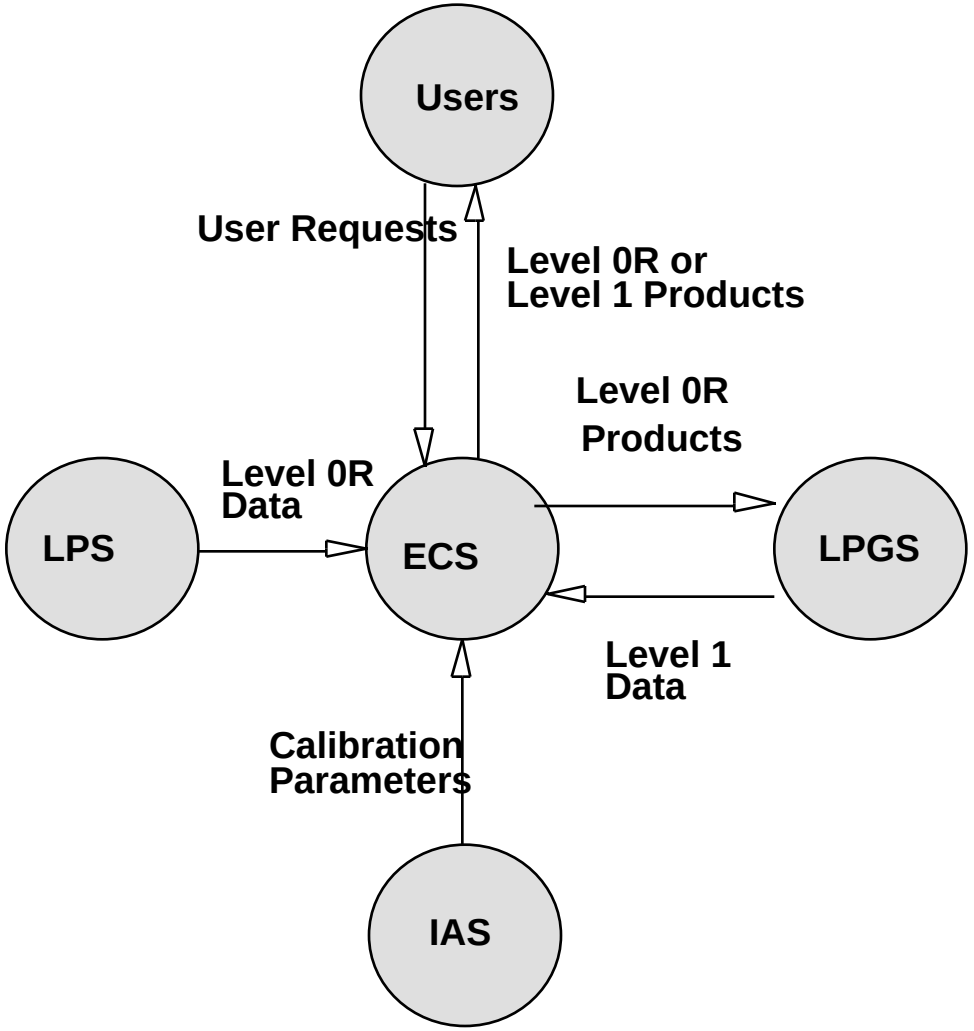
SYSTEM CONCEPT



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EXTERNAL INTERFACES

- **IAS I/F tentatively documented in draft IAS/LPGS ICD**
  - **Expect to export characterization results from LPGS database**
  - **Database file transferred via ftp to IAS**
  - **Network connectivity between IAS and ECS to be determined**
    - **EDC Exchange LAN connectivity to IAS currently assumed**
    - **If network connectivity provided may be able to use COTS s/w to provide database file**
    - **If no network connectivity custom s/w must be developed to provide database file**

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External Interfaces (Cont)

- ECS I/F options under analysis
  - TCP/IP communications currently assumed in design
  - DCE communications are under consideration
    - 40% of Data Management Subsystem code no longer obtained through reuse
    - Currently in the initial stages of dialogue with ECS developers
- DHF I/F currently under consideration
  - Concepts will be included in DHF Mission Concept that is under development
  - Expect some anomaly reports to be provided to the DHF
  - Network connectivity to ECS to be determined

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REVISED ARCHITECTURE (1 of 2)

- Architecture modified due to I/O performance concerns(RID#18)
- Image processing centralized on SGI Origin 2000 server to limit data moves
- Off-line analysis supported by SGI 02 Workstation
- Development and Test supported by a backup Origin 2000
- RAID disk array to provide failsafe data storage - connects to both servers
- Color Printer is being provided by EDC institutional equipment

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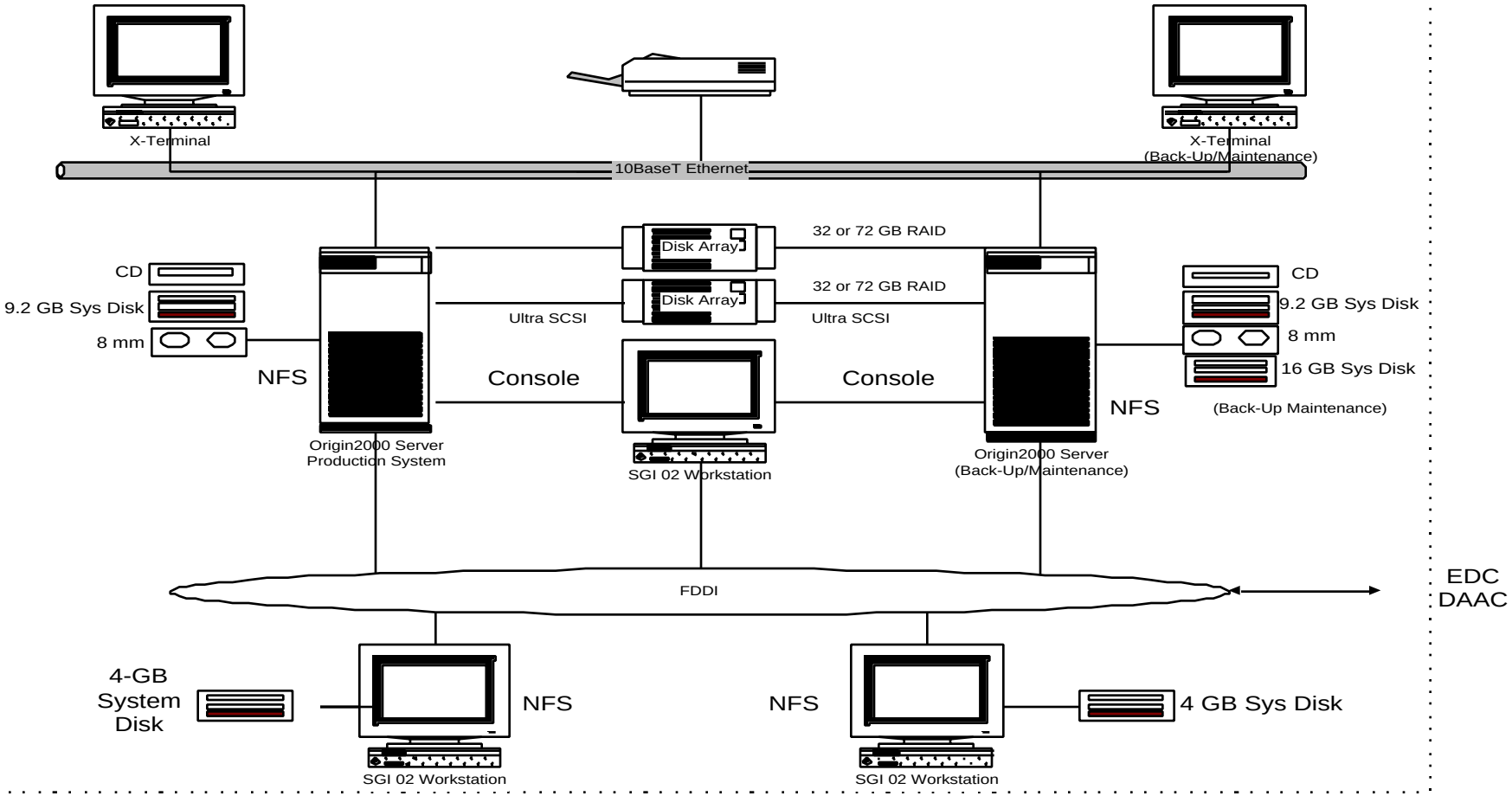
REVISED ARCHITECTURE(2 of 2)



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PERFORMANCE ANALYSIS

- **Performance modeling effort underway**
- **Interim results:**
  - **All Radiometric algorithms were modeled**
  - **Geometric performance extrapolated from EDC prototype report**
  - **“Tall Pole” in Radiometric processing is Memory Effect correction**
    - **65% of total radiometric processing**
    - **Takes @ 2 minutes per band for each WRS scene**
    - **“Improved algorithm in development”**

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Operations Concept Overview

- Operations concept modifications since SRR/SDR
- Operations scenario development

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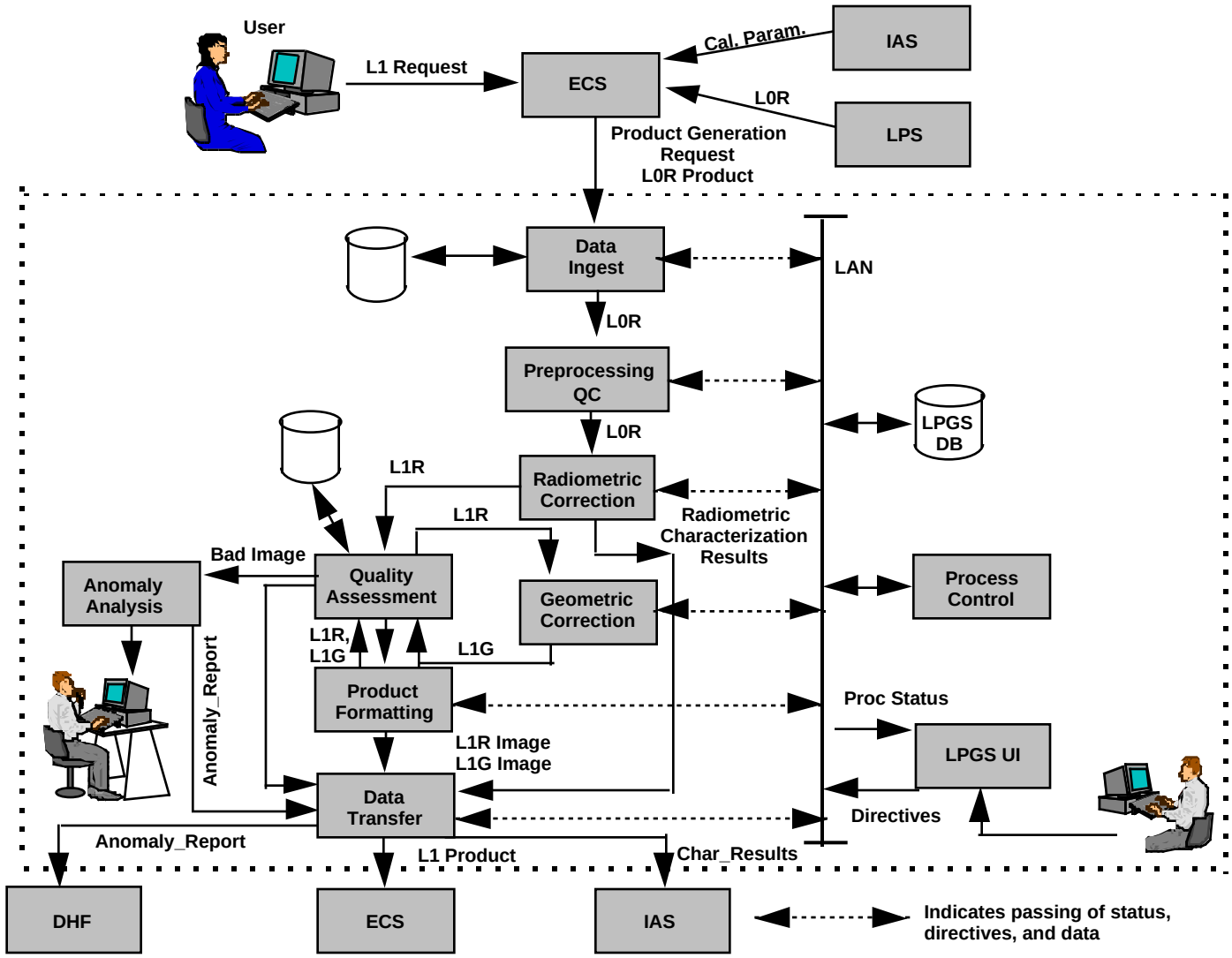
LPGS Preliminary Design Walkthrough

LPGS Processing Flow



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Operations concept modifications since SRR/SDR

- Problem reporting
  - Trouble tickets no longer received from or transmitted to ECS
  - DAAC Manager distributes, to LPGS, reports from customers of problems introduced by LPGS production
    - Problem information manually keyed into LPGS to maintain an on line record
    - Problem resolution information provided to DAAC Manager and DHF
- Accounting information and statistics
  - Accounting information no longer exchanged with ECS
  - L1 production information generated by LPGS for internal use and expected to be provided to DAAC Manager

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Operations concept modifications (cont'd)

- L1 product packaging
  - L 1 products no longer 'packaged' by ECS
  - LPGS will provide entire contents of L1 product to ECS
    - ECS will not have to access previously archived files to distribute L1 products
    - Files such as CPF and IC data that are included in L1R product will be provided back to ECS for distribution to customers
  - LPGS will distribute the 'consensus' PCD and MSCD files in the L1R product
    - Formats 1 and 2 files will be combined to form a 'value-added' file
  - L1G FAST products will be distributed in FAST-C format

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Operations scenario development (1 of 2)

- Scenarios provided in PDS
  - Nominal Activities
    - Startup LPGS
    - Shutdown LPGS
    - Process L1 Product (Nominal end-to-end L1 processing flow)
    - Cancel L1 Processing
    - Transfer Characterization Results to IAS
  - Non-nominal Activities
    - Analyze Problem Report
    - Process L1 Product (non-nominal)
    - Recover from LPGS Failure
    - Respond to ECS Communications Link Failure
    - Generate and Distribute Statistics

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Operations scenario development (2 of 2)

- Outlines flow of activities between subsystems and ops staff
- Provide basis for a dialogue among systems engineering, development, and operations staff
- Intended to be modified and clarified for CDR
- Assumes operations positions that include System Operator, Production Operator, and Analyst
  - Assumes that multiple operations positions may be staffed by a single individual
  - Actual staffing profile determined by EDC DAAC management
- Worst case scenario under development
  - Currently identifying processing bottlenecks based on ongoing performance analysis
  - Defining visual analysis activities which must be included
  - Baseline worst case scenario will be presented at CDR

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LPGS Design Philosophy

- Automate processing to support “lights out” operation
- Provide manual override capabilities
- Single electronic interface to ECS to minimize impact to other subsystems
- IAS reuse
  - Translate product requests into work orders
  - Extend use of script processing to include some DMS and QAS functions
  - Manage data on a work order basis
- Interprocess communication
  - Sockets
  - Database
  - Script

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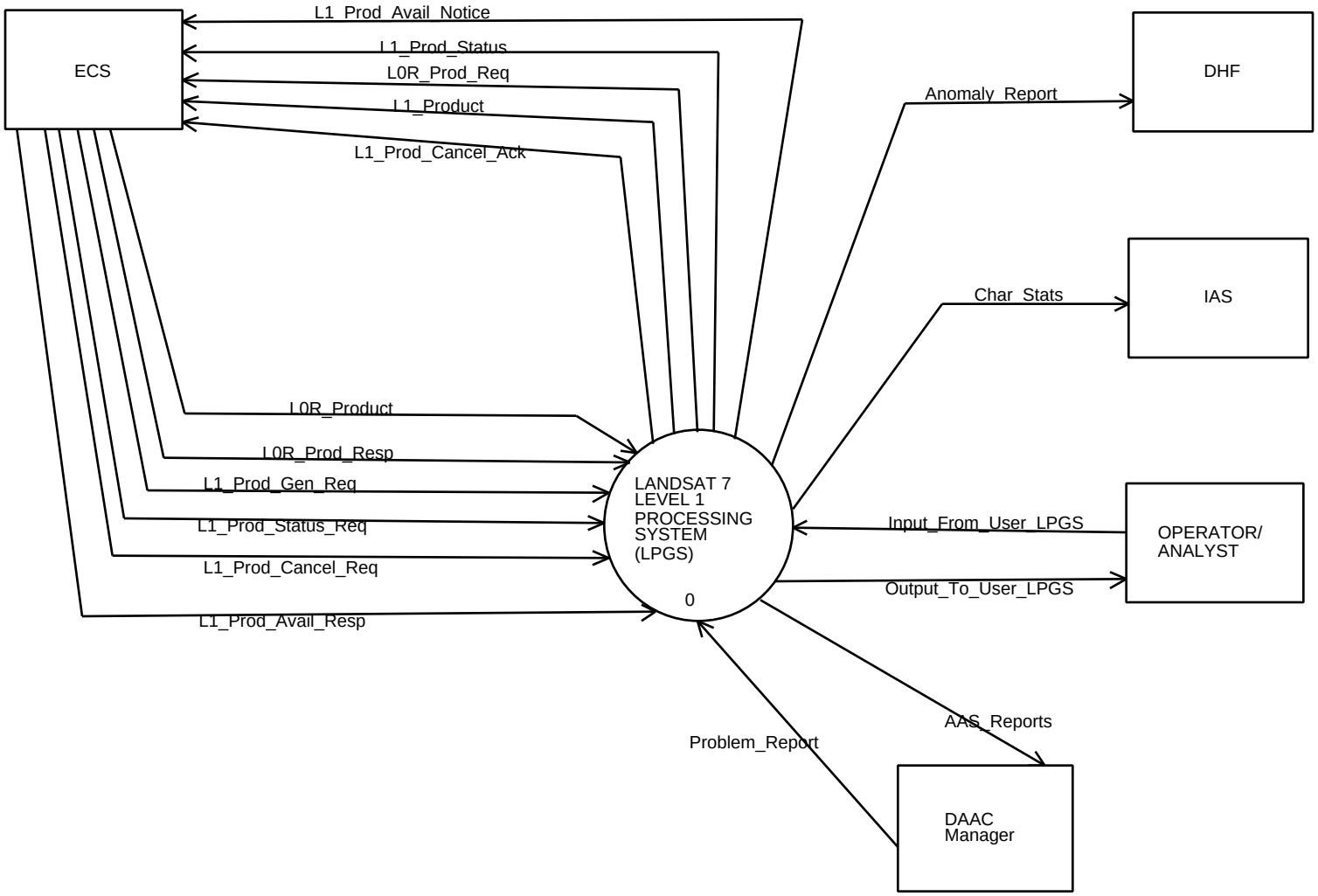
LPGS Preliminary Design Walkthrough

LPGS Context Diagram



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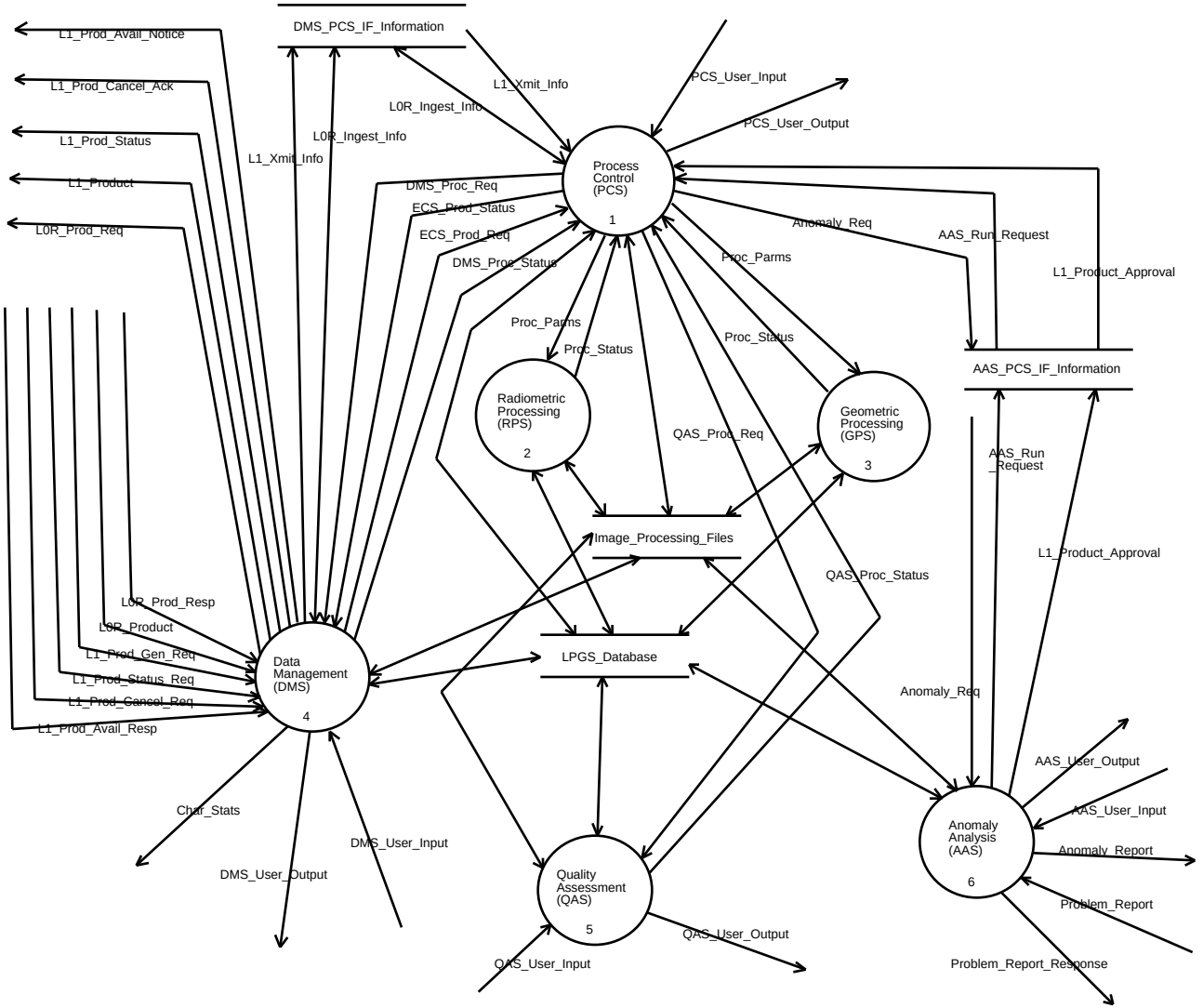
LPGS Level 0 Data Flow Diagram



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LPGS Preliminary Design Walkthrough

Process Control Subsystem (PCS)

- **Purpose**
- **Driving requirements**
- **Subsystem context diagram**
- **Design assumptions**
- **Task model**
- **Task descriptions**

LPGS Preliminary Design Walkthrough

PCS Purpose

- **Provides automated control of product request scheduling and processing**
  - **Supports manual operations including visual assessment and anomaly investigations**
- **Provides automated control of product request cancellations with optional confirmation by the operator**
- **Provides a manual capability for viewing and adjusting LPGS production schedules**

LPGS Preliminary Design Walkthrough

PCS - Driving Requirements

Number	Requirement Description
3.1.1	The LPGS shall nominally generate Level 1 digital images on a first ordered, first processed (FIFO) basis.
3.1.2	The LPGS shall provide the capability to move a Level 1 image processing work order within the FIFO queues according to operator direction.
3.1.11	The LPGS shall provide the capability to support unattended, automatic processing 16 hours per day, 7 days per week, on a continuous basis.
3.1.15	The LPGS shall provide the capability to control LPGS operations.
3.1.16	The LPGS shall provide the capability to monitor LPGS operations.
3.2.1	The LPGS shall interface with the ECS to receive:
3.2.1.2	Level 1 image processing requests
3.2.1.4	Production status requests
3 2.1.5	Product cancellation requests

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PCS - Driving Requirements

Number	Requirement Description
3.2.2	The LPGS shall interface with the ECS to coordinate the transfer of the following:
3.2.2.1	LPGS L1 digital images
3.2.2.2	Processing status
3.2.2.3	Production quality and accounting information
3.2.2.4	L1 processing statistics
3.3.8.6	The LPGS shall provide the capability to manually override the LPGS automated processing functions.
3.3.8.7	The LPGS shall provide the manual capability to cancel Level 1 processing prior to completion of digital image generation.

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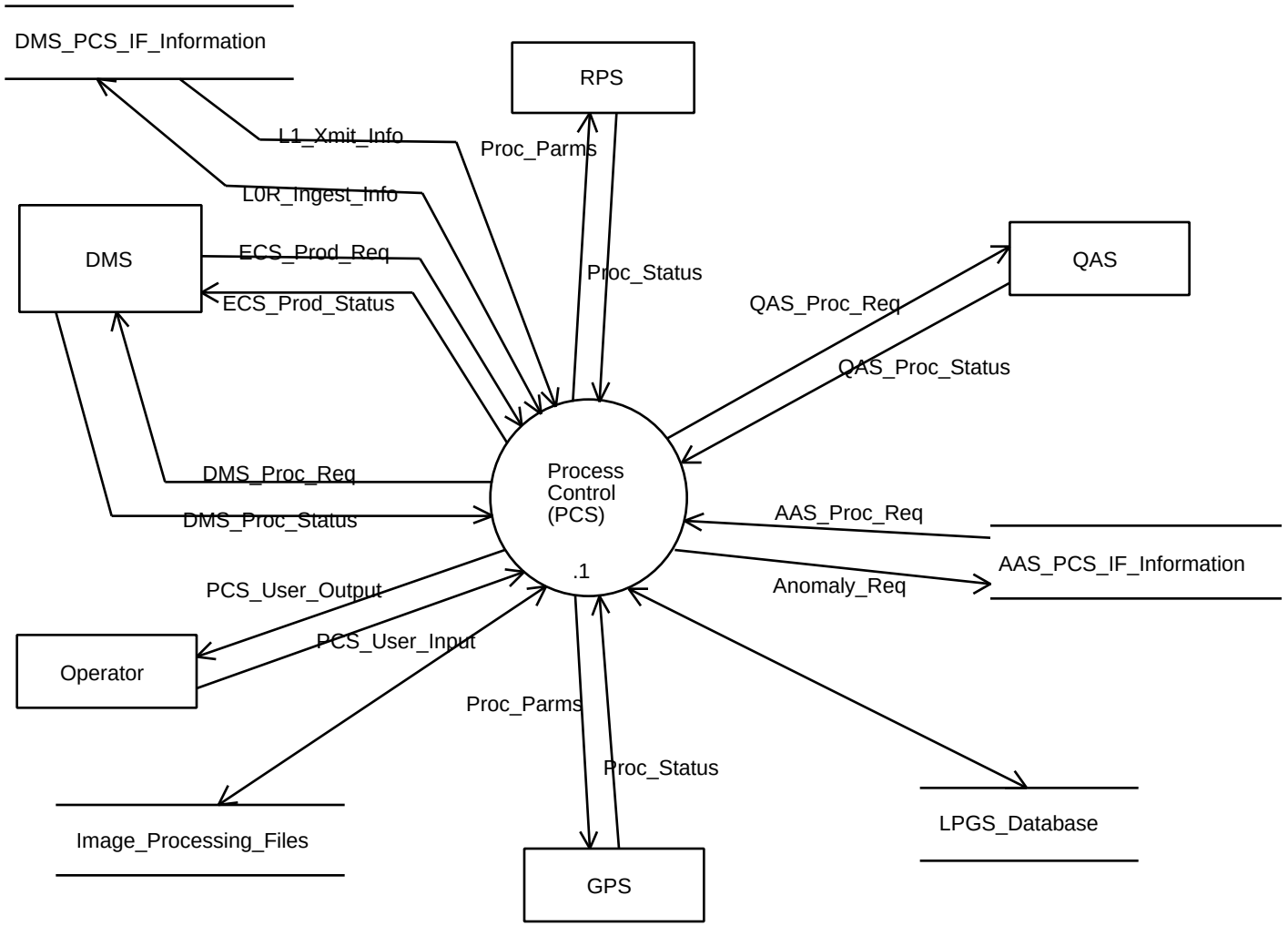
PCS Context Diagram



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PCS - Design Assumptions

- **IAS reuse**
  - **Work Order Scheduler**
  - **Work Order Controller**
- **Product Request**
  - **Prevalidated by ECS**
  - **Provides unique identifier for tracking**
  - **Supplies the options needed to control L1R and L1G processing**
- **WO Concurrent Processing**
  - **Supports processing of work orders in parallel**
  - **Uses parameters to restrict system resource utilization**

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PCS - Design Assumptions (cont'd)

- **Visual Quality Assessment (QA)**
  - **Use parameter to indicate when visual QA is required**
  - **Performed at a pause point in script processing**

- **Cancellation Confirmation Option**
  - **Use parameter to specify whether explicit operator confirmation is required**
  - **If confirmation is required, PCS continues processing the WOs until it receives the operator's confirmation directive**

- **Cancellation Points**
  - **Supports cancellation of a product request at any point prior to notifying DMS that product is ready for shipment**
  - **Waits for an executing WO script to terminate before performing a cancellation on its product request**

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PCS Tasks

PCS consists of 4 tasks:

- **PCS Request Processor (PRQ)**
- **PCS Work Order Generator (PWG)**
- **PCS Work Order Scheduler (PWS)**
- **PCS Work Order Controller (PWC)**

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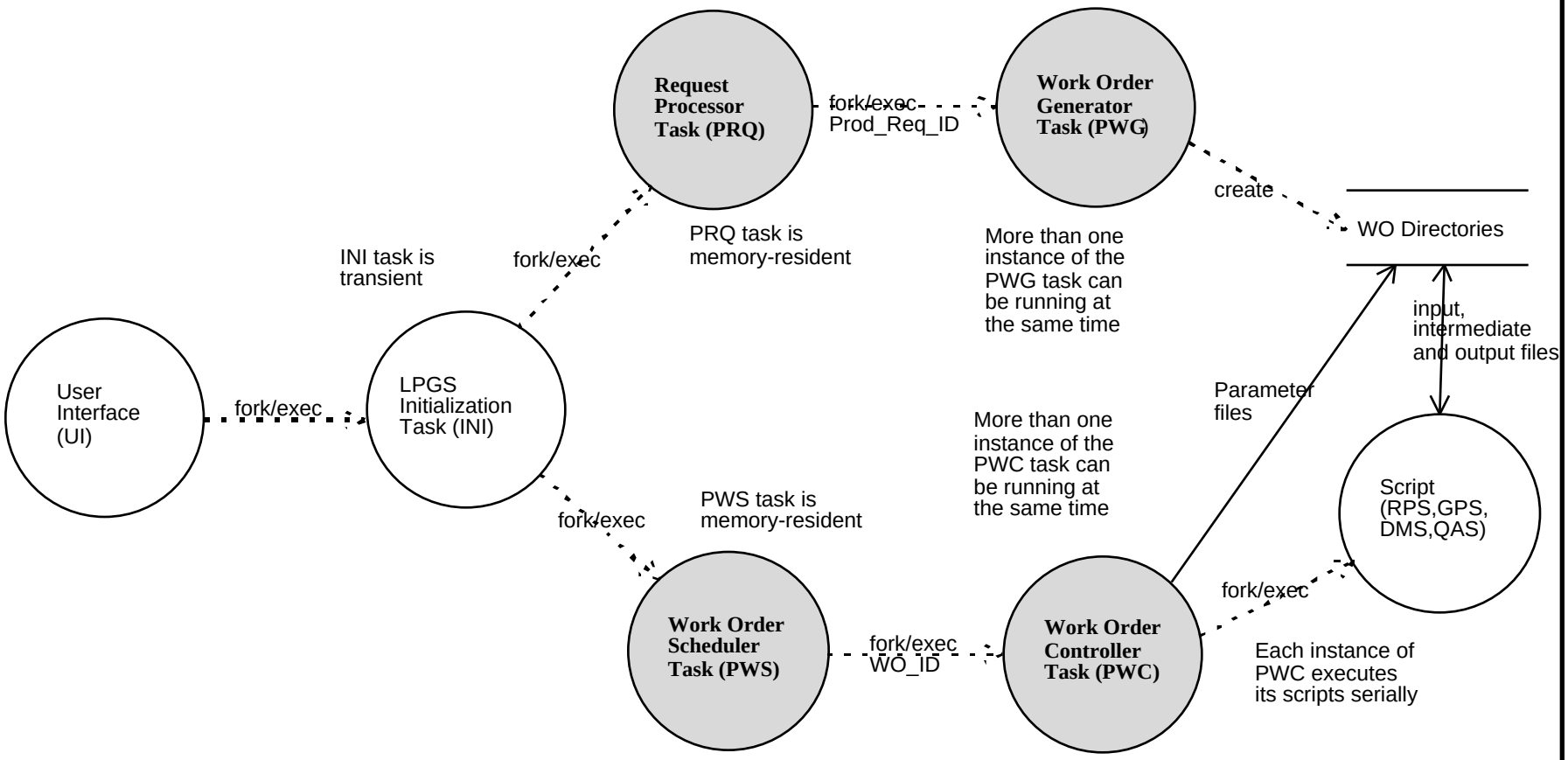
PCS Task Model



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Request Processor (PRQ) Task

- **Processes product generation requests**
  - **Records product generation request in LPGS database**
  - **Starts PWG task**
- **Processes production status requests**
  - **Retrieves status information from the database**
  - **Sends response to DMS for forwarding to ECS**
- **Processes product cancellation requests**
  - **Performs product cancellations, when possible, as soon as requests are received**
  - **Sends ackowledgement message to DMS for forwarding to ECS indicating final disposition of request**

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Work Order Generator (PWG) Task

- Receives product request ID as input parameter from PRQ
- Generates a work order (WO) for the generation request and stores the work order information in the LPGS database
- Creates WO directories for holding input, intermediate and output files to be associated with the WO

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Work Order Scheduler (PWS) Task

- Polls database to identify work to be done
  - WOs that are ready to be resumed
  - WOs for which L0 data is available on LPGS
  - WOs that are ready for shipment
- Selects next work order to be started
  - FIFO order except when operator explicitly promoted the WO
- Checks for a confirmed cancellation request for the WO and performs the cancellation if necessary
- Checks that there are sufficient system resources to start the WO
- Starts PWC task to actually start/resume the WO

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Work Order Controller (PWC) Task

- Receives work order ID as an input parmeter from PWS
- Processes work order scripts in sequence
  - Checks for a confirmed cancellation request and performs the cancellation if necessary
  - Builds the environment for the script
  - Starts the script using fork/exec
  - Waits for completion of the script
  - Checks the script's status upon completion

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Work Order Controller (PWC) Task (cont'd)

- Terminates processing when
  - Script status indicates an error or anomaly condition was encountered
  - WO indicates a pause is required
  - Last script is completed
- Notifies AAS when anomaly is encountered
- Notifies DMS when product is ready for shipment

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Radiometric and Geometric Processing Subsystems(RPS and GPS)

- Will be integrated into the LPGS
- Invoked by PCS initiated scripts
- RPS functions
  - Perform radiometric characterization
  - Perform radiometric correction
- GPS functions
  - Create systematically corrected L1G image

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Radiometric and Geometric Processing Subsystems(RPS and GPS)

- **Inputs**
  - **Script parameter specifies the location of the ODL file**
  - **ODL file provides all parameters needed to control processing**
  - **Work order directories contain all other data needed for processing**

- **Outputs**
  - **Output files (L1R/L1G) are stored in work order directories**
  - **Trending data is stored in the database**
  - **Work order log file used for standard output**

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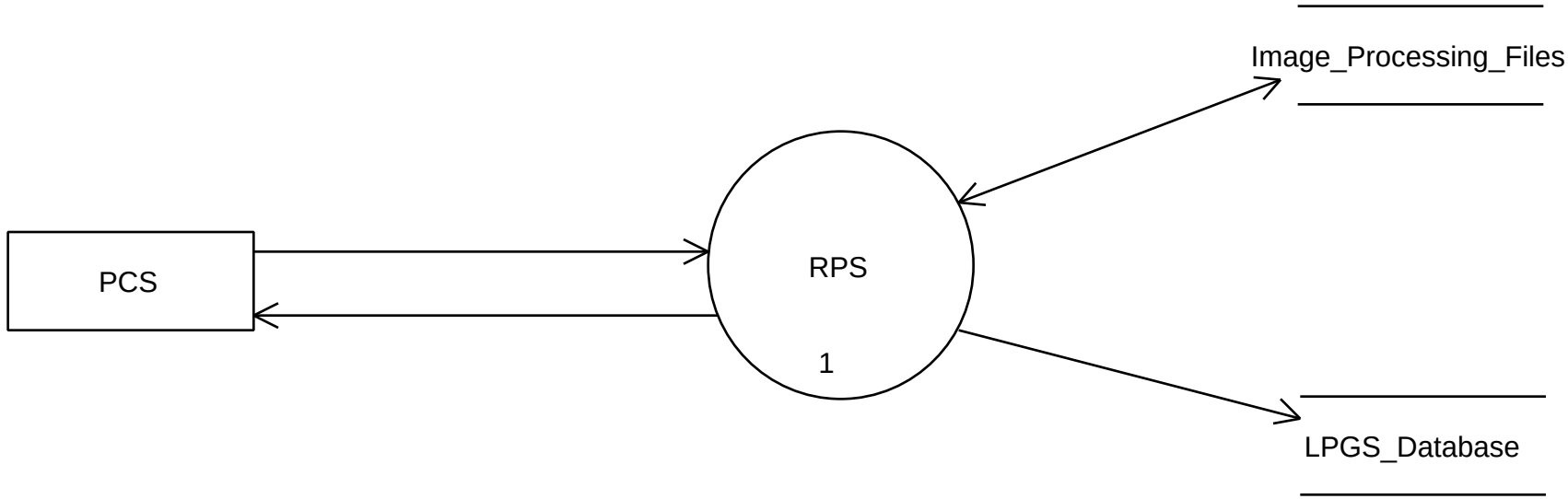
RPS Subsystem Context Diagram



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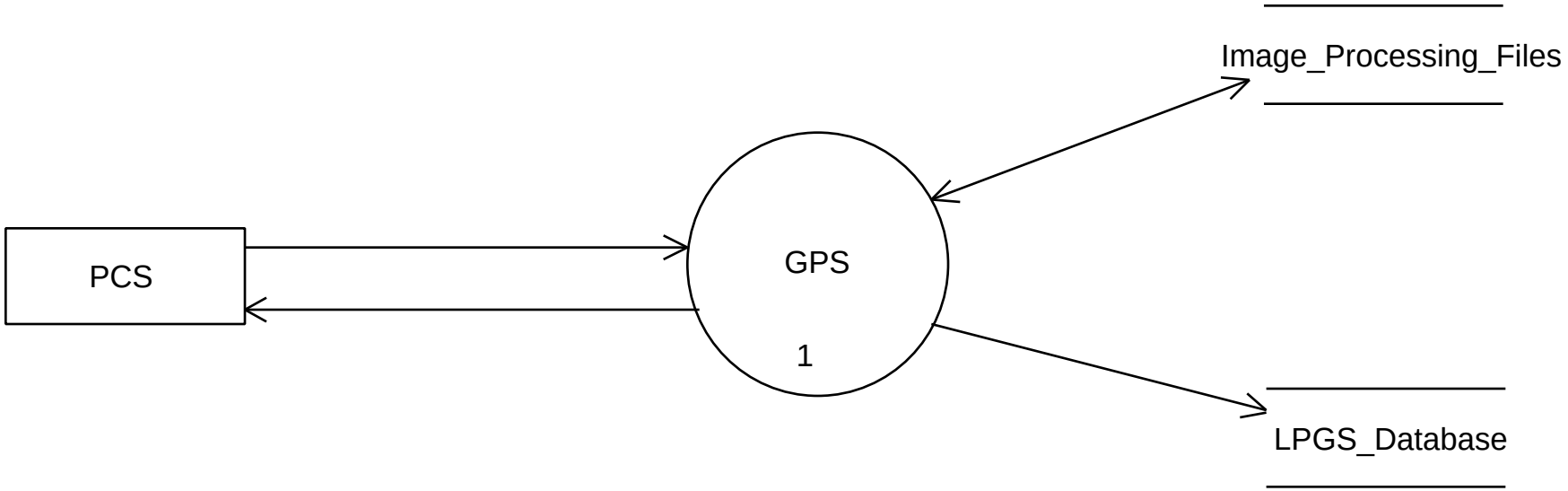
GPS Subsystem Context Diagram



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Data Management Subsystem (DMS) Purpose

- Manages the electronic interface with ECS
  - Acquires Level-0 products required for Level-1 product generation
  - Transfers the Level-1 products
  - Receives product generation, status and cancellation requests
  - Transmits product status and cancellation acknowledgments
- Packages/unpackages and verifies/validates products
- Manages data associated with work order processing
- Provides reports and statistics to local and remote entities

LPGS Preliminary Design Walkthrough

DMS Key Requirements

Number	LPGS Requirement
3.1.11	The LPGS shall provide the capability to support unattended, automatic processing 16 hours per day, 7 days per week, on a continuous basis.
3.2.1	The LPGS shall interface with the ECS to receive:
3.2.1.1	L0R files (includes associated PCD, MSCD, and CPF)
3.2.1.2	Level 1 image processing requests
3.2.1.3	Data availability notification
3.2.1.4	Production status requests
3.2.1.5	Product cancellation requests
3.2.2	The LPGS shall interface with the ECS to coordinate the transfer of the following:
3.2.2.1	LPGS L1 digital images
3.2.2.2	Processing status
3.2.2.3	Production quality and accounting information
3.2.2.4	L1 processing statistics
3.2.2.5	L1 metadata
3.2.2.6	PCD file (consensus)
3.2.2.7	MSCD file (consensus)

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DMS Key Requirements (cont'd)

Number	LPGS Requirement
3.2.2	(continued)
3.2.2.8	IC data file
3.2.2.9	CPF
3.2.2.10	Geolocation table
3.3.2.11	The LPGS shall assemble and append to the L1R digital images all of the applicable metadata, quality and accounting data gathered in the construction of the L1R digital image. The complete L1R digital image package contains the following data elements as a minimum:
3.3.2.11.1	Level 1R digital image (all requested bands)
3.3.2.11.2	Level 1 metadata file
3.3.3.8	The LPGS shall assemble and append to the L1G digital images all of the applicable metadata, quality and accounting data gathered in the construction of the L1G digital image. The complete L1G digital image package contains the following data elements as a minimum:
3.3.3.8.1	Level 1G digital image (all requested bands)
3.3.3.8.2	Level 1 metadata file

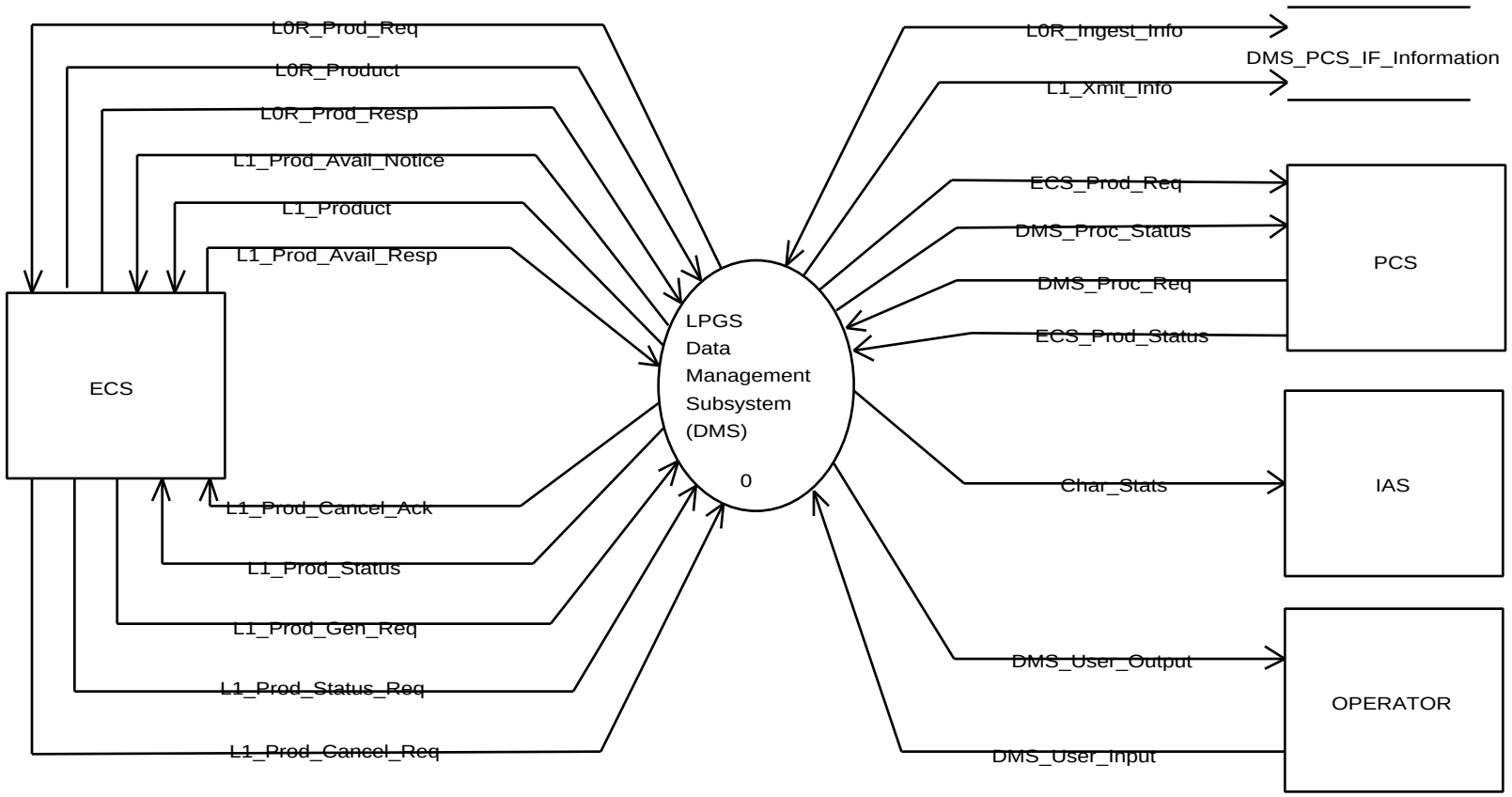
LPGS Preliminary Design Walkthrough

DMS Key Requirements (cont'd)

Number	LPGS Requirement
3.3.6.1	The LPGS shall be able to output Level 1 digital images in the following formats:
3.3.6.1.1	HDF-EOS (L1R and L1G)
3.3.6.1.2	EOSAT FAST (L1G only)
3.3.6.1.3	GeoTIFF (L1G only)
3.3.6.2	The LPGS shall transfer L1 files to ECS per the ECS to LPGS ICD.
3.3.6.3	The LPGS shall provide the capability to display LPGS Level 1 file transfer summary upon operator request.
3.3.6.4	The LPGS shall be able to detect files which have been successfully transferred.
3.3.6.5	The LPGS shall be able to mark successfully transferred files as candidates for deletion from LPGS temporary storage.
3.3.7.1	The LPGS shall be able to provide temporary online storage for the equivalent of 3 days of completed products.
3.3.7.2	The LPGS shall be able retransmit files located in temporary storage.
3.3.7.3	The LPGS shall be able to store Level 1 processing information online for 90 days.

LPGS Preliminary Design Walkthrough

DMS Context Diagram



LPGS Preliminary Design Walkthrough

DMS Design Assumptions

- Reuse DAN protocol software based on the heritage of the Sensor Data Processing Facility (SDPF) design
- Reuse IAS software
  - L0R Characterization statistic generation
  - Consensus MSCD & PCD generation
  - Resource management
- Ingest process determines when the L0R data is requested from ECS
- ECS FTPs L0R products to the LPGS disk
  - Ingested files always written into a single, fixed-name directory
  - Restricting ECS write access to one directory gives the LPGS operator almost 100% ownership control of the LPGS disk
- COTS products available for conversion to GeoTIFF, FAST & HDF format

LPGS Preliminary Design Walkthrough

DMS Design Assumptions (cont'd)

- L1R product in HDF format consists of
  - L1R image files (one for each requested band)
  - Calibration Parameter File
  - Scan line offset files (Format 1 & 2)
  - PCD & MSCD Consensus Files
  - LPS & LPGS Metadata files (includes processing quality info)
  - IC calibrator data (Format 1 & 2)
  - Geolocation Table File
- L1G product in HDF format consists of
  - L1G image files (one for each requested band)
  - LPGS Metadata file (includes processing quality info)
- L1G product in FAST-C format consists of
  - L1G image files (one for each requested band)
  - Header file (metadata stored in header file)

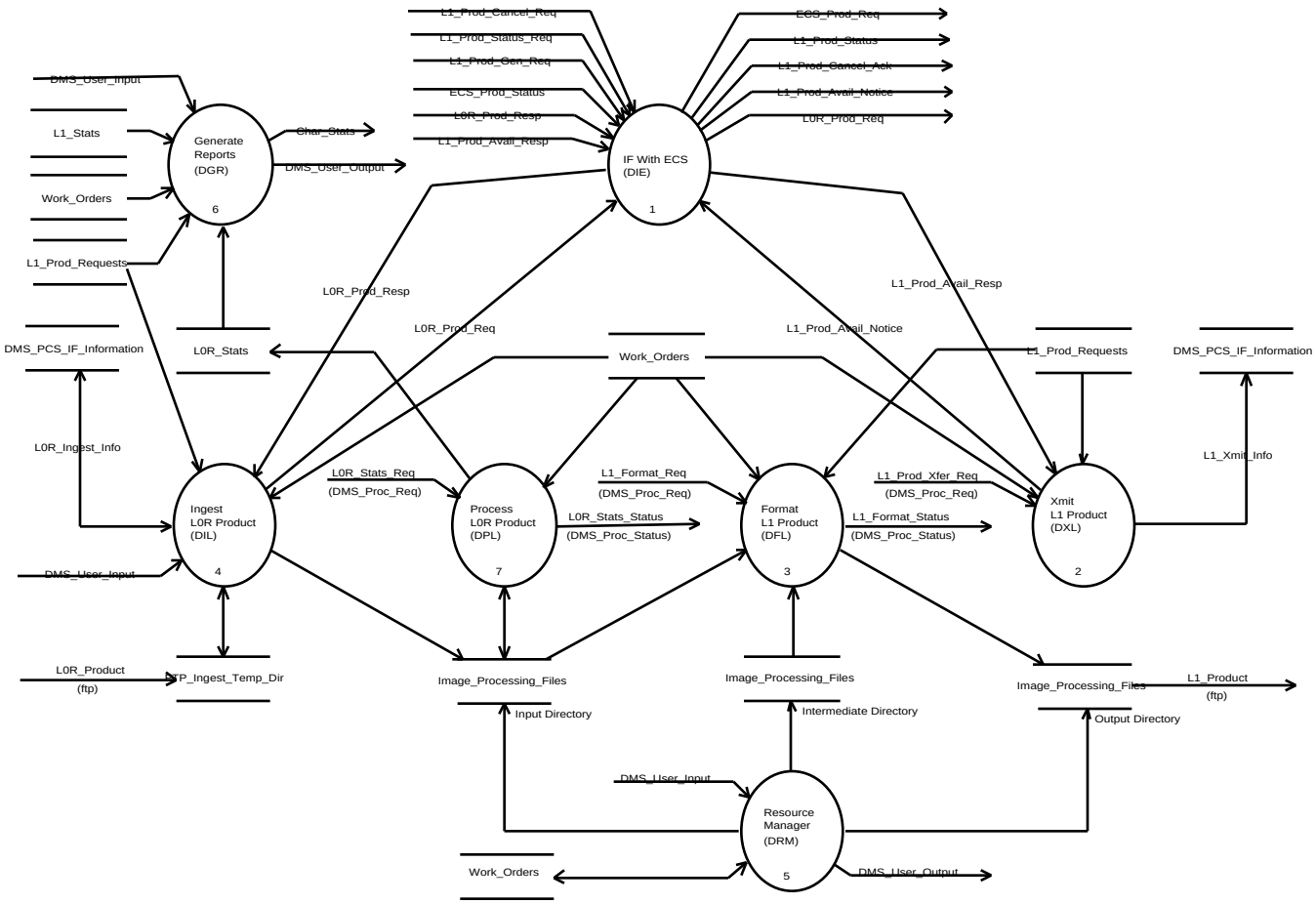
LPGS Preliminary Design Walkthrough

DMS Design Assumptions (cont'd)

- L1 product retrieved by ECS from work order output subdirectory
- DMS marks work order files and directories for deletion after L1 product is successfully transferred to ECS
- DMS periodically cleans up the disk
  - Deletes files marked for deletion
  - ONLY work order associated files and directories
  - Time period between disk clean ups configurable by the operator

LPGS Preliminary Design Walkthrough

DMS Data Flow Diagram



LPGS Preliminary Design Walkthrough

Data Management Subsystem Tasks

Data Management Subsystem (DMS) divided into seven tasks

- **DMS Interface with ECS (DIE)**
- **DMS Ingest L0R Product (DIL)**
- **DMS Process L0R Product (DPL)**
- **DMS Format L1 Product (DFL)**
- **DMS Xmit L1 Product (DXL)**
- **DMS Generate Reports (DGR)**
- **DMS Resource Manager (DRM)**

LPGS Preliminary Design Walkthrough

DIE Task

- Responsible for message transfer between LPGS and ECS
- Provides a single electronic LPGS interface with ECS
  - Receives processing requests, cancellation requests, status requests, and product transfer protocol messages
  - Transmits processing status, cancellation status, and product transfer protocol messages
- Routes messages to and from DIL, DXL, and PCS processes
- Controls data transfers
  - Performs handshaking
  - Throttles traffic
  - Verifies interfaces are available for communication
- Detects data transmission and intertask communication errors
  - Reported to the operator and written to the system error log file

LPGS Preliminary Design Walkthrough

DIL Task

- Responsible for ingesting L0R products from ECS
- Sends ECS L0R product requests after ingest criteria met, e.g.
  - Availability of disk space
  - Prestaging time period
  - Preventing overloading ECS
- Receives notice when L0R product is available in ingest directory
  - Checks product for completeness and consistency with request
  - Moves product to the appropriate work order input directory
  - Catalogs the L0R products in the database
- Times data transmission to detect transfer failures
  - Errors reported to the operator & written to system error log file
- Operator can
  - Modify thresholds for the ingest criteria
  - Modify time out period for receipt of L0R product from ECS

LPGS Preliminary Design Walkthrough

DPL Task

- Invoked by PCS initiated script
- Responsible for preparing L0R data for L1 product generation
- Verifies data quality within operator modifiable thresholds before L1 product generation
- Generates consensus PCD and MSCD files

LPGS Preliminary Design Walkthrough

DFL Task

- Invoked by PCS initiated script
- Responsible for formatting L1 product based on user request
- Converts L1 product components, L1R image, and L1G image files into HDF format
- Converts L1G image into GeoTIFF or FAST-C format
- Packages L1R or L1G product
- Moves L1 product into the work order output directory
- Checks L1 product for completeness

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DXL Task

- Responsible for the transmission of L1 product to ECS
- Image products transferred from the output work order directory
- Receives notification from PCS when the L1 Product is ready for transfer
- Notifies ECS when the product is ready for transfer
- Receives notification after the product was transferred
- Updates database to indicate transfer status
- Marks work order associated files for deletion
- Times data transmission to detect transfer failures
  - Errors reported to the operator & written to system error log file
  - Time out period modifiable by the operator

LPGS Preliminary Design Walkthrough

DRM Task

- Responsible for managing data associated with work orders
- Periodically deletes file and directories marked for deletion
- Updates database to indicate files were deleted
- Periodically reports disk usage
- Operator Interface
  - Requests to delete work order files and directories
  - Modify time period for file deletion and disk usage checks
  - Modify threshold for maximum disk utilization

LPGS Preliminary Design Walkthrough

DGR Task

- Responsible for generating reports
- Periodically provides IAS with the characterization statistics
  - Time period modifiable by the operator
  - Manual request to provide statistics to IAS immediately
- Generates operator requested reports

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LPGS Preliminary Design Walkthrough

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• Closing Comments	R. Schweiss

LPGS Preliminary Design Walkthrough

QAS - Purpose

The Quality Assessment Subsystem (QAS)

- **Provide automated postproduction information about image artifacts**
- **Provide a summary of the processed image quality**
- **Provide capability with GUI tools to view images and reports**

LPGS Preliminary Design Walkthrough

QAS - Driving Requirements

Number	Requirement Description
3.1.11	The LPGS shall provide the capability to support unattended, automatic processing 16 hours per day, 7 days per week, on a continuous basis.
3.2.4	LPGS shall interface with the DHF to provide L1 processing anomaly reports.
3.3.5.1	The LPGS shall support automatic assessment of L1 digital image quality.
3.3.5.2	The LPGS shall be able to optionally display any single band of the L1R digital image for visual quality assessment.
3.3.5.3	The LPGS shall be able to optionally display any single band of the L1G digital image for visual quality assessment
3.3.5.4	The LPGS shall be able to optionally print a color hardcopy of the display of any band(s) of the L1R digital image for visual quality assessment.
3.3.5.5	The LPGS shall be able to optionally print a color hardcopy of the display of any band(s) of the L1G digital image for visual quality assessment.
3.3.8.4	The LPGS shall provide an option to display L1 digital image quality status and statistics at operator request.
3.3.8.5	The LPGS shall provide an option to print L1 digital image quality status and statistics at operator request.

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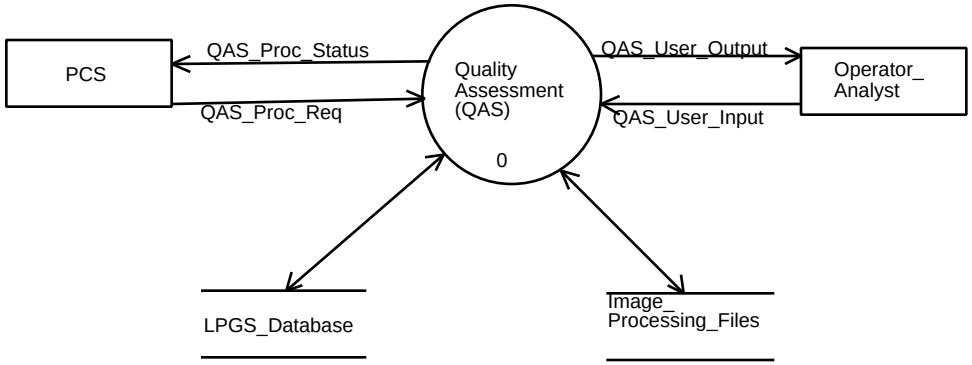
QAS Context Diagram



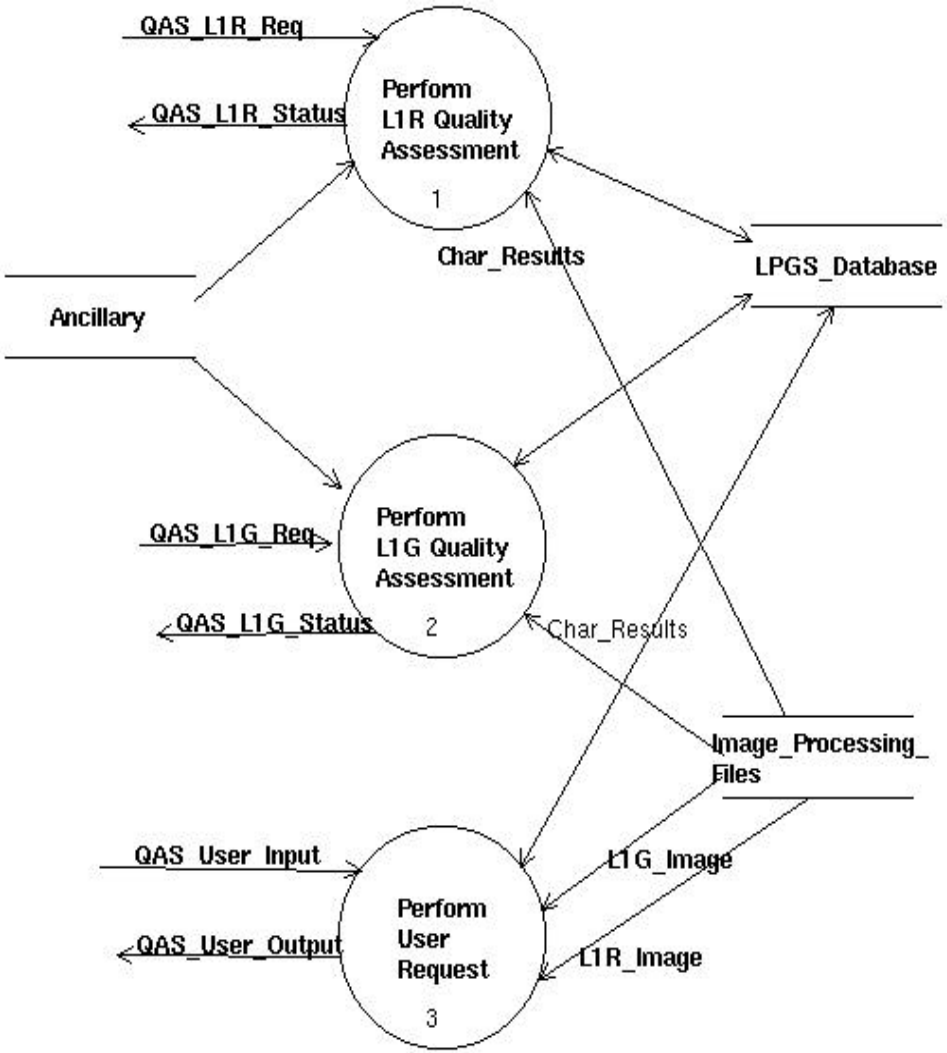
LPGS Preliminary Design Walkthrough

QAS - Design Assumptions

- Utilize COTS packages
  - ENVI for Visual Quality Assessment
  - IDL programming language
- Reuse of applicable IAS software
- An image expert will identify combinations of thresholds and characterizations for determining image quality
- Default QA thresholds
  - maintain as parameters
  - user can modify

LPGS Preliminary Design Walkthrough

QAS Data Flow Diagram



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QAS - Task Design

- The QAS is broken into 3 tasks:
  - an automated L1R Quality Assessment Task (Q1R)
  - an automated L1G Quality Assessment Task (Q1G)
  - a manual Quality Assessment User Interface (QUI)

LPGS Preliminary Design Walkthrough

QAS - Q1R Task Design

- Invoked by PCS script following L1R Correction and Characterization
- Uses L1 Radiometric processing results for the Q1R assessment
- Uses a combination of L1R threshold(s) and characterization(s) to determine the image quality
- Notifies PCS if an L1R image fails a threshold(s) check
  - action required by Anomaly Assessment Subsystem (AAS)
  - image processing halted until AAS analysis completed
- Writes a production Quality Report to the intermediate workorder directory

LPGS Preliminary Design Walkthrough

QAS - Q1G Task Design

- Invoked by PCS script following L1G Correction and Characterization
- Uses L1 Geometric processing results for the Q1G assessment
- Uses L1G threshold(s) to determine the image quality
- Notifies PCS if an L1G image fails a threshold check
  - action required by Anomaly Assessment Subsystem (AAS)
  - image processing halted until AAS analysis completed
- Writes a production Quality Report to the intermediate workorder directory

LPGS Preliminary Design Walkthrough

QAS - QUI Task Design

- Uses COTS for Quality User Interface
- Displays any single band of L1R or L1G digital image for visual quality assessment
- Prints a color hardcopy of the display of any band(s) of the L1R and L1G digital image for visual quality assessment
- Provides an option to display L1 digital image quality status and statistics
- Provides an option to print L1 digital image quality status and statistics
- Provides interface for final visual image check before product is shipped

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LPGS Preliminary Design Walkthrough

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Anomaly Analysis Subsystem (AAS) - Purpose

- Analyze and resolve LPGS production type anomalies
- Generate an Anomaly Report for the Data Handling Facility (DHF)
- Analyze and resolve anomalies from problem reports that are received for an L1 image that has been distributed to the customer
- Generate response to Problem Report

LPGS Preliminary Design Walkthrough

AAS - Driving Requirements

Number	Requirement Description
3.1.13	The LPGS shall provide the capability to execute diagnostic tests for verifying proper operation of system capabilities and components
3.1.14	The LPGS shall provide the capability to support end-to-end testing of Level 1 processing functions
3.1.16	The LPGS shall provide the capability to monitor LPGS operations
3.2.4	The LPGS shall interface with the Data Handling Facility (DHF) to provide Level 1 processing anomaly reports

LPGS Preliminary Design Walkthrough

AAS - Driving Requirements (cont'd)

Number	Requirement Description
3.3.5.2	The LPGS shall be able to optionally display any single band of the L1R digital image for visual quality assessment
3.3.5.3	The LPGS shall be able to optionally display any single band of the L1G digital image for visual quality assessment
3.3.5.4	The LPGS shall be able to optionally print a color hard copy of the display of any band(s) of the L1R digital image for visual quality assessment
3.3.5.5	The LPGS shall be able to optionally print a color hard copy of the display of any band(s) of the L1G digital image for visual quality assessment

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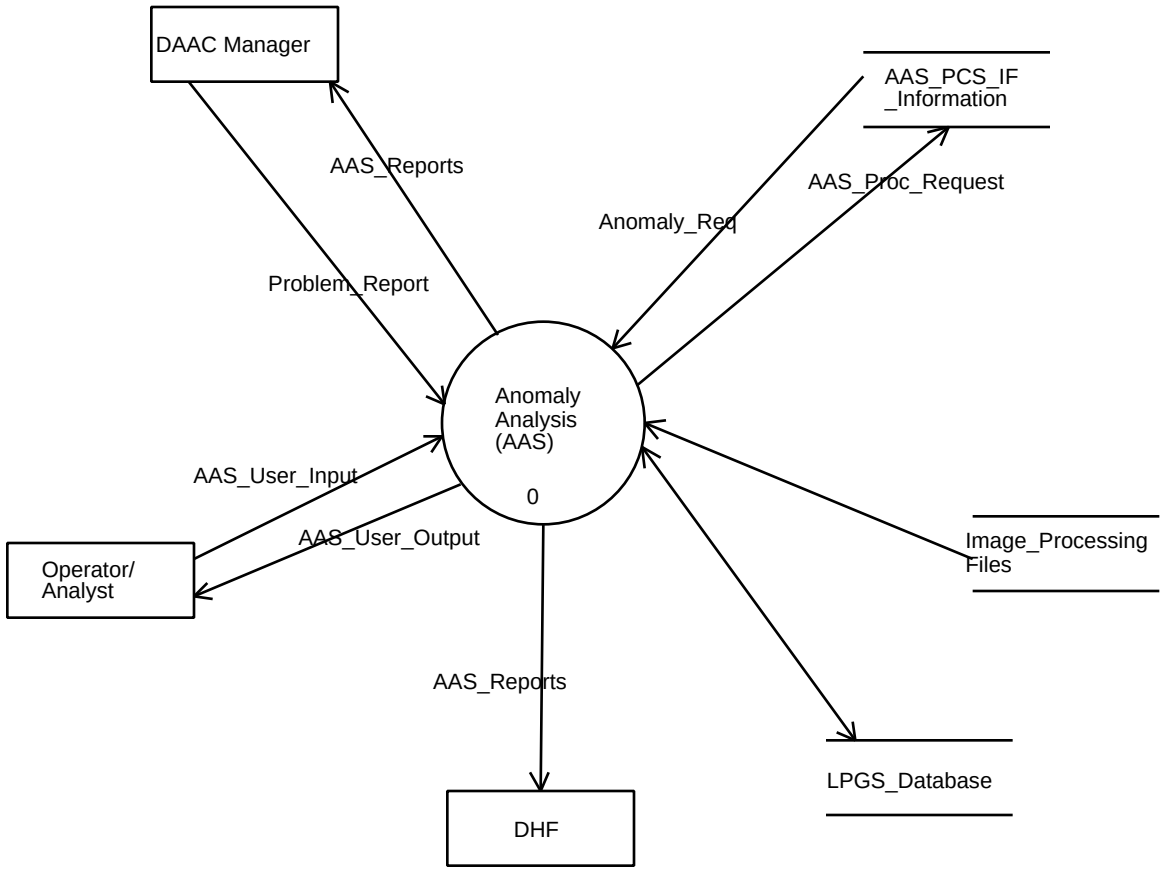
AAS - Context Diagram



LPGS Preliminary Design Walkthrough

AAS - Design Assumptions

- Problem reports will be received via hard copy or e-mail
- When a problem report is resolved
  - Corrected L1 product is saved
  - Resolution of problem is forwarded to DAAC manager, including location of L1 product
- Resolve production problems only
- Forward scientific problems to the DHF

LPGS Preliminary Design Walkthrough

AAS - Design Strategy

- Reuse IAS Evaluation and Analysis Subsystem for
  - AAS analyst interface
  - Work order setup
  - Control of script processing
  - Examining files and database stores
  - Viewing images
- Primarily relies upon an integrated set of COTS software packages - ENVI, IDL, ORACLE, FRAMEMAKER

LPGS Preliminary Design Walkthrough

AAS Subsystem - Design Strategy (cont'd)

- Supplement with some additional customized application software for
  - Updating Anomaly Status Table
  - Generating Anomaly Report
  - Generating Problem Report Response
  - Updating History Data Store
  - Generating Anomaly History Report
  - Transmitting Anomaly Report
  - Transmitting Problem Report Response

LPGS Preliminary Design Walkthrough

AAS - Design Strategy (cont'd)

COTS Products that will be Used

- **ENVI (Environment for Visualizing Images)**
  - Provides a customizable graphical user interface for the AAS subsystem
  - A sophisticated tool for image visualization
  - Provides user interface to the other COTS tools
  - Implemented in IDL
- **IDL (Interactive Data Language)**
  - Designed for general purpose data visualization, and application development
  - Text widget enables viewing of Run Log, ASCII output files, etc.

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AAS - Design Strategy (cont'd)

COTS Products (cont'd)

- **Oracle**
  - **Oracle forms used by the AAS Analyst for database queries and Work Order submissions**
- **Framemaker**
  - **Document publishing software package that includes page layout, word processing, graphics and tables**
  - **Used to generate AAS reports**

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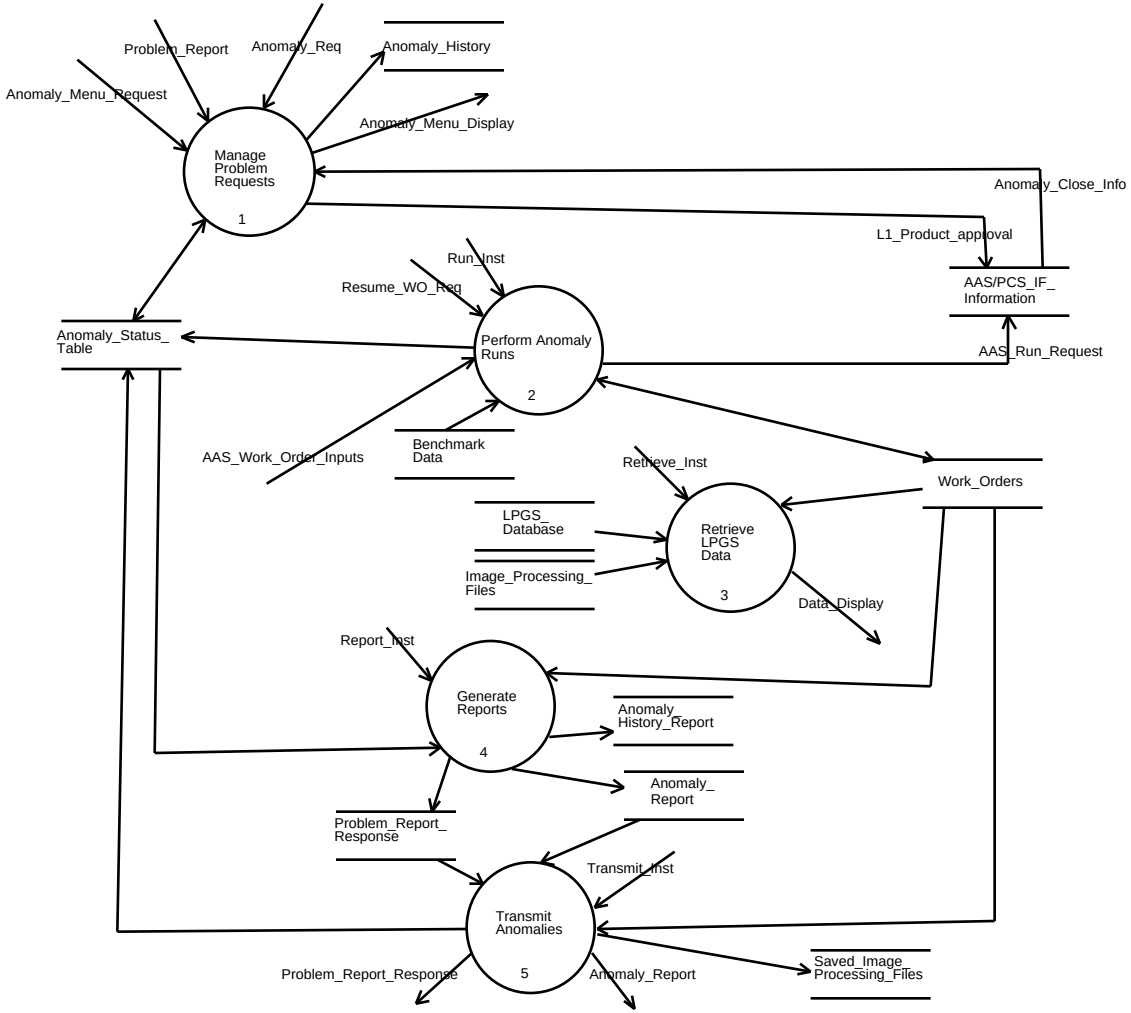
AAS - Primary Functions



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AAS - Manage Problem Requests

- Receives internal anomaly requests
- Receives problem report
- Tracks anomalies
- Approves L1 product after anomaly is corrected
- Closes out anomaly

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AAS - Perform Anomaly Runs

- Generates diagnostic work order
- Generates reprocessing work order
- Generates benchmark work order

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AAS - Retrieve LPGS Data

- Displays L0 , L1, and intermediate images
- Displays data files
- Displays database tables

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AAS - Generate Reports

- Generates Anomaly Report
- Generates Problem Report Response
- Generates Anomaly History Report

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AAS - Transmit Anomalies

- **Transmits Anomaly Report to the DHF**
- **Transmits Problem Report Response to the DHF**

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LPGS Preliminary Design Walkthrough

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LPGS Preliminary Design Walkthrough

Nominal Processing - Assumptions

- The following scenario assumes
  - Generation of the L1G product was requested
  - Visual assessments of the product image quality were made after both L1R and L1G processing and after formatting of the output product
  - The output product passes all visual quality assessments

means direct link via message, alert or invocation

means indirect link via database

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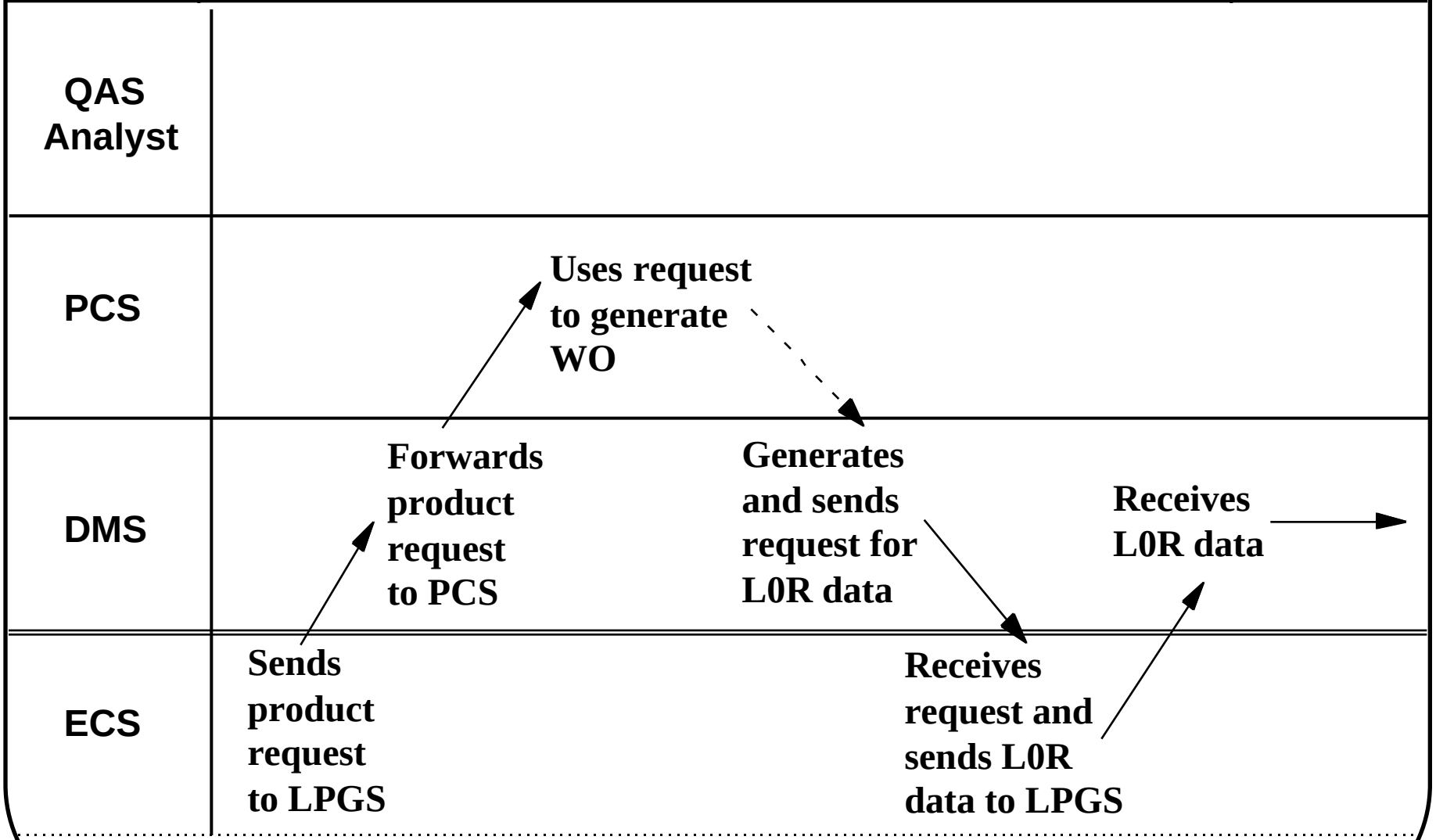
LPGS Preliminary Design Walkthrough

Nominal Processing of L1 Product (1 of 6)



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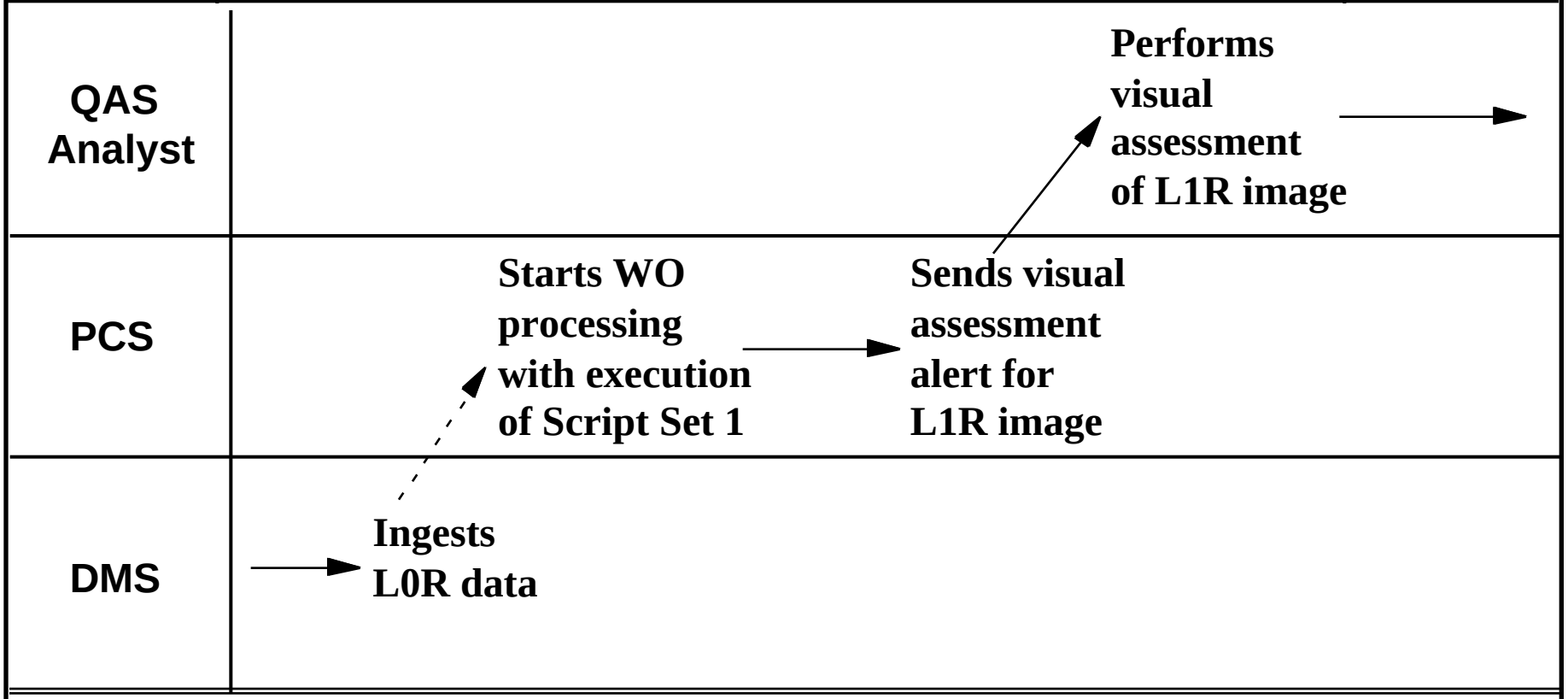
LPGS Preliminary Design Walkthrough

Nominal Processing of L1 Product (2 of 6)



- Script Set 1
  - Process L0R product (DPL)
  - Perform radiometric characterization and corrections (RPS)
  - Perform automated quality assessment of L1R image (QAS)

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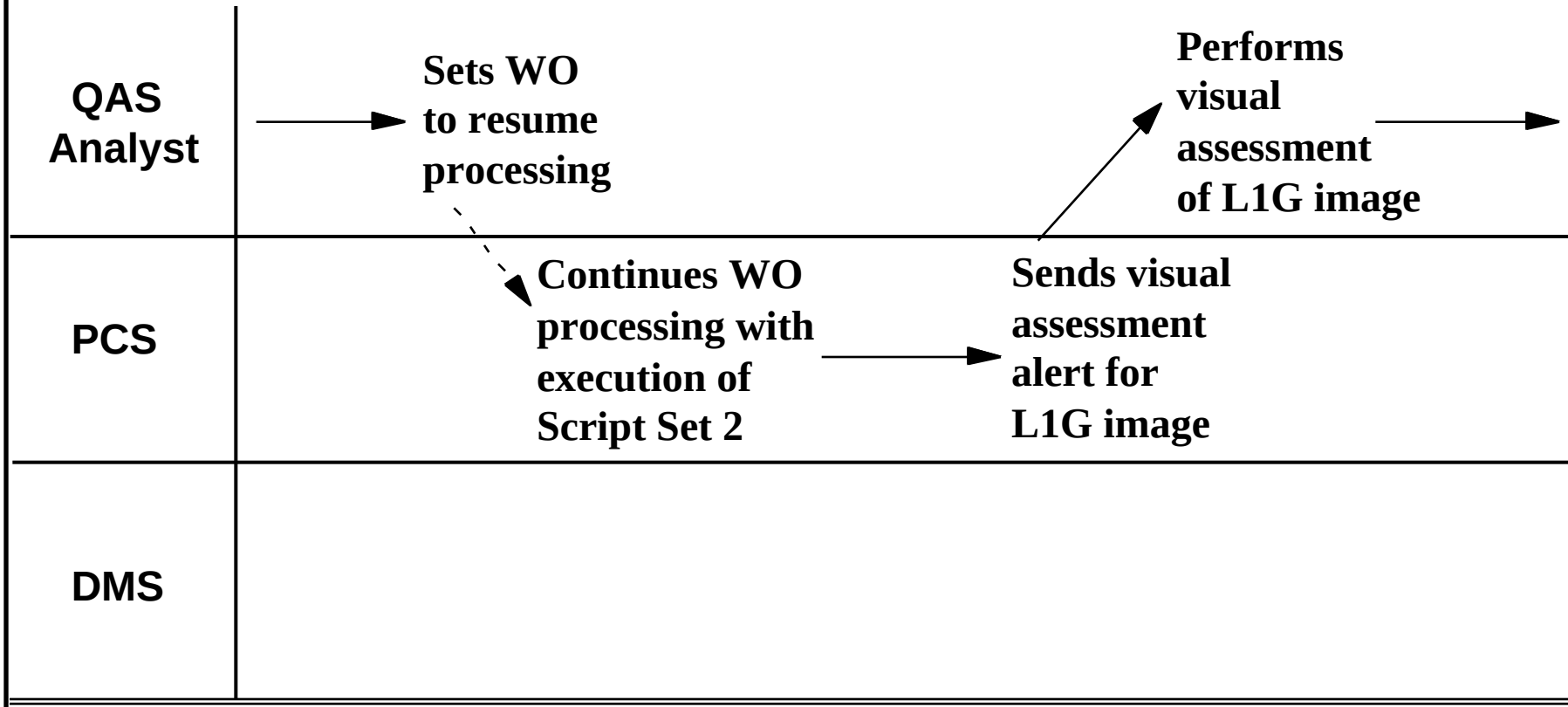
LPGS Preliminary Design Walkthrough

Nominal Processing of L1 Product (3 of 6)



- Script Set 2
  - Perform geometric corrections (GPS)
  - Perform automated quality assessment of L1G image (QAS)

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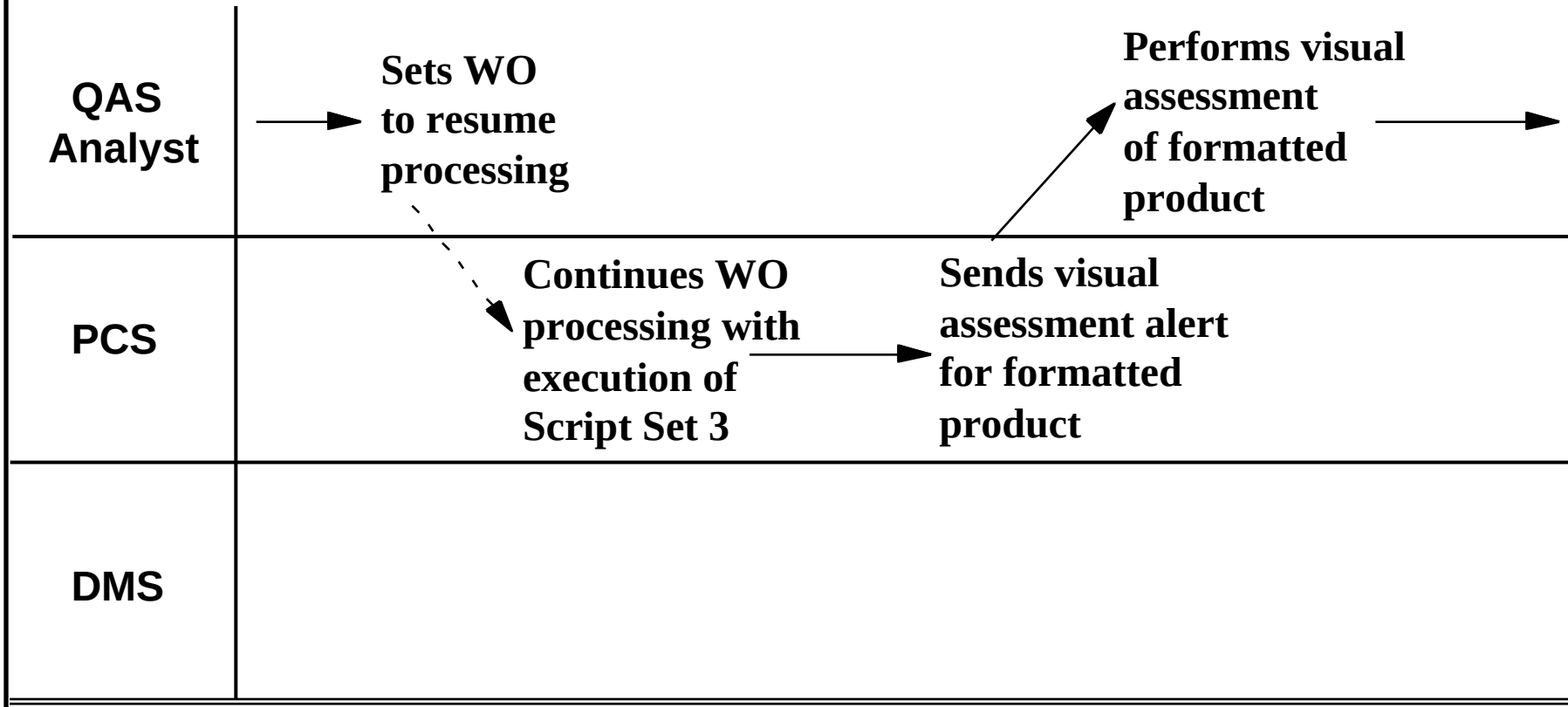
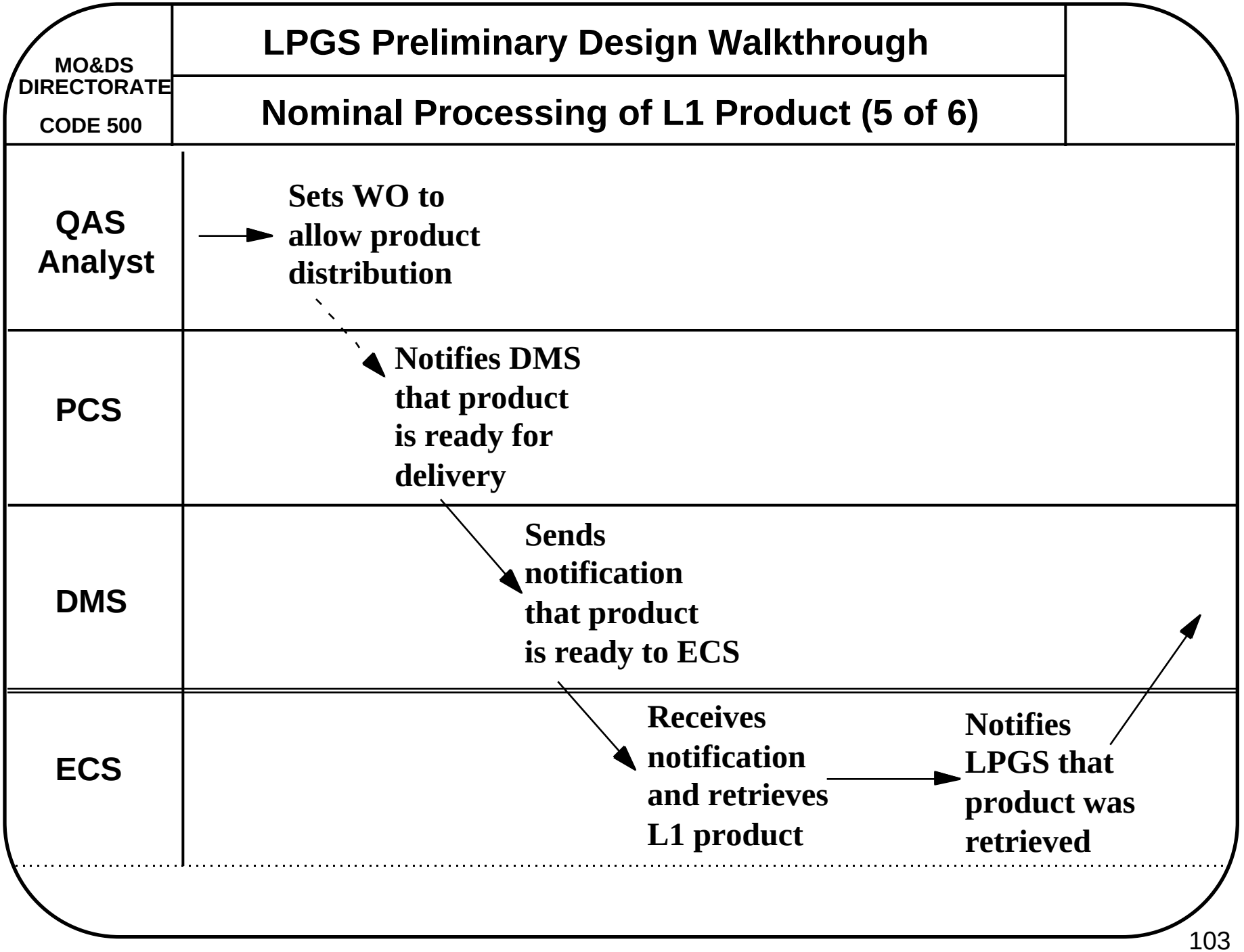
Nominal Processing of L1 Product (4 of 6)



- **Script Set 3**
  - **Format and package the L1 product and check it for completeness (DFL)**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LPGS Preliminary Design Walkthrough
Nominal Processing of L1 Product (5 of 6)
QAS Analyst
Sets WO to allow product distribution
PCS
Notifies DMS that product is ready for delivery
DMS
Sends notification that product is ready to ECS
ECS
Receives notification and retrieves L1 product
Notifies LPGS that product was retrieved

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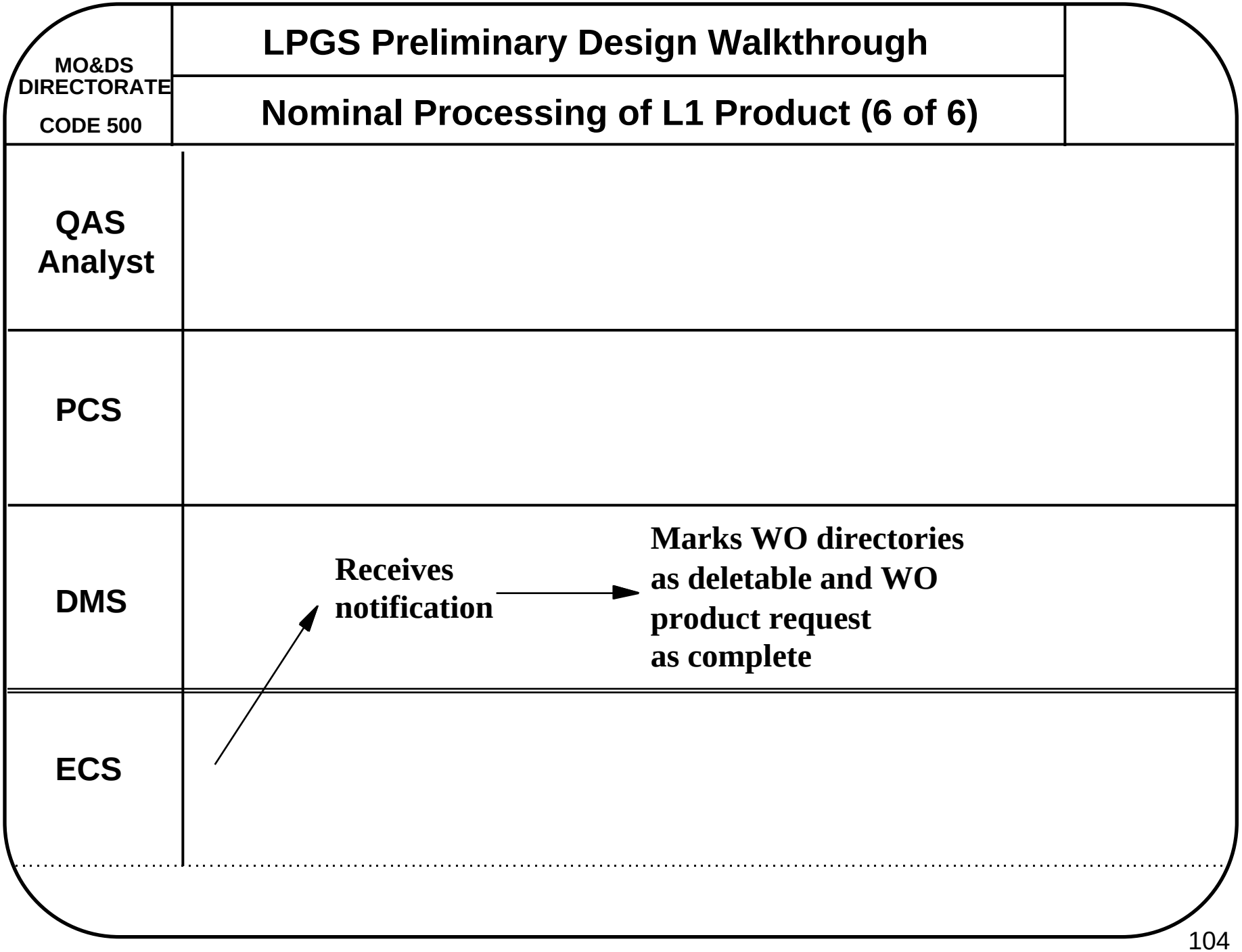
Nominal Processing of L1 Product (6 of 6)



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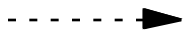
Non-Nominal Processing - Assumptions

- The following scenario assumes
  - The automated and visual assessments of the product image quality failed after L1G processing on the original WO
  - A benchmark run had to be made to rule out the LPGS system as the cause of the problem
  - Problem was completely resolved using a set of diagnostic runs based on the original WO
  - The reprocessing run to generate an acceptable product was successful

means direct link via message, alert or invocation



means indirect link via database

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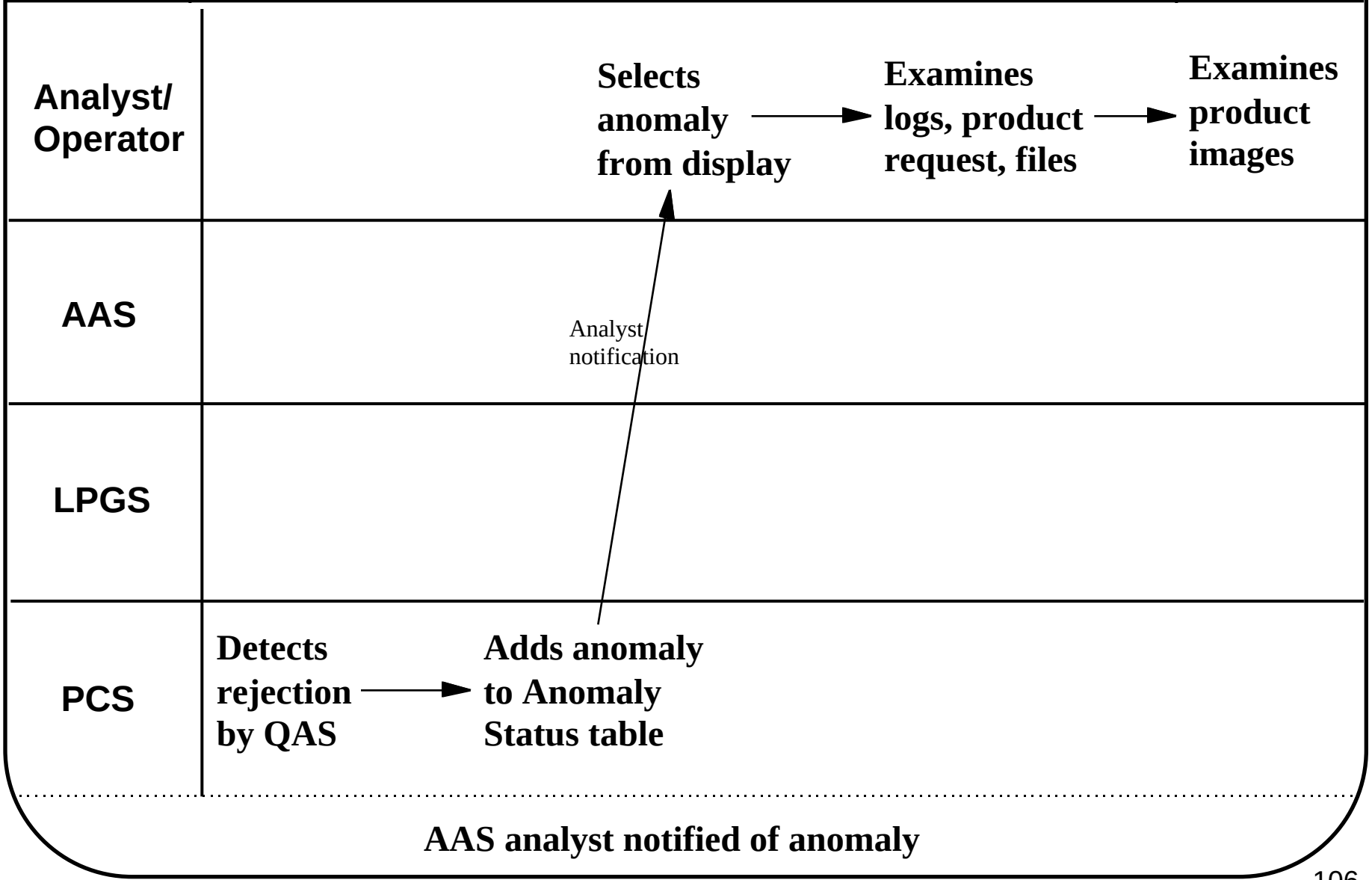
Non-Nominal Processing of L1 Product (1 of 5)



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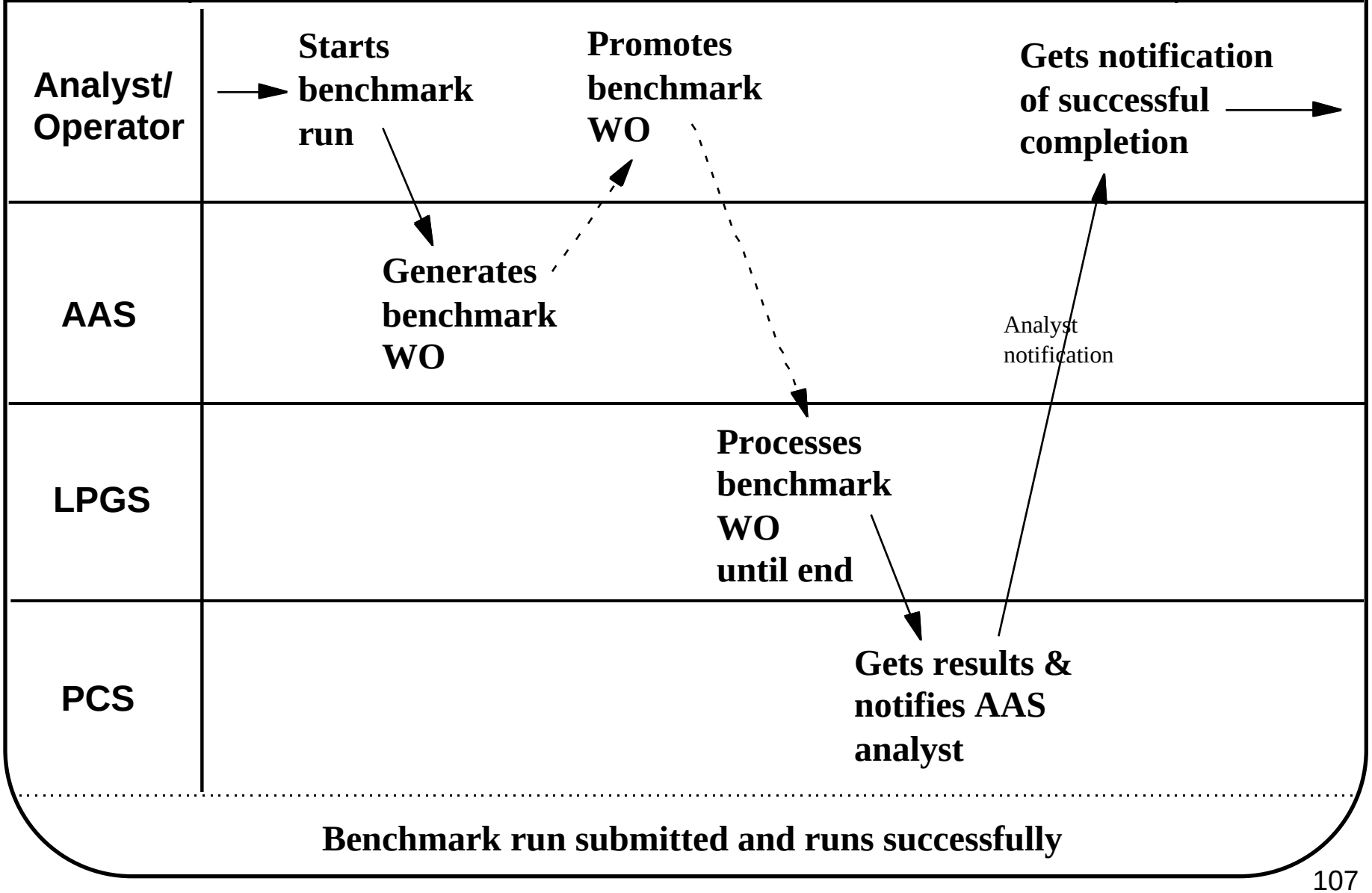
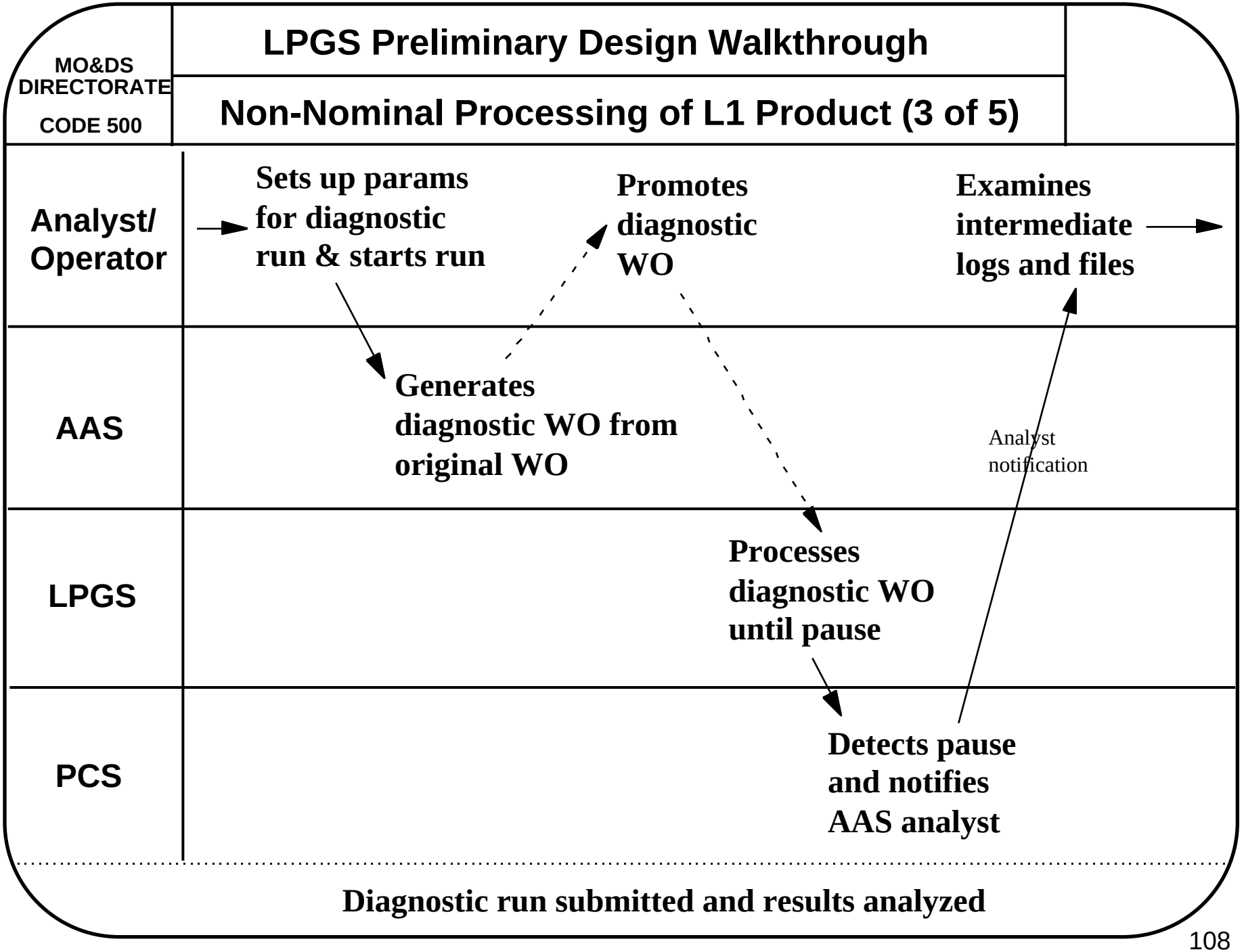
Non-Nominal Processing of L1 Product (2 of 5)

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LPGS Preliminary Design Walkthrough
Non-Nominal Processing of L1 Product (3 of 5)
Analyst/ Operator
AAS
LPGS
PCS
Sets up params for diagnostic run & starts run
Promotes diagnostic WO
Examines intermediate logs and files
Generates diagnostic WO from original WO
Analyst notification
Processes diagnostic WO until pause
Detects pause and notifies AAS analyst
Diagnostic run submitted and results analyzed

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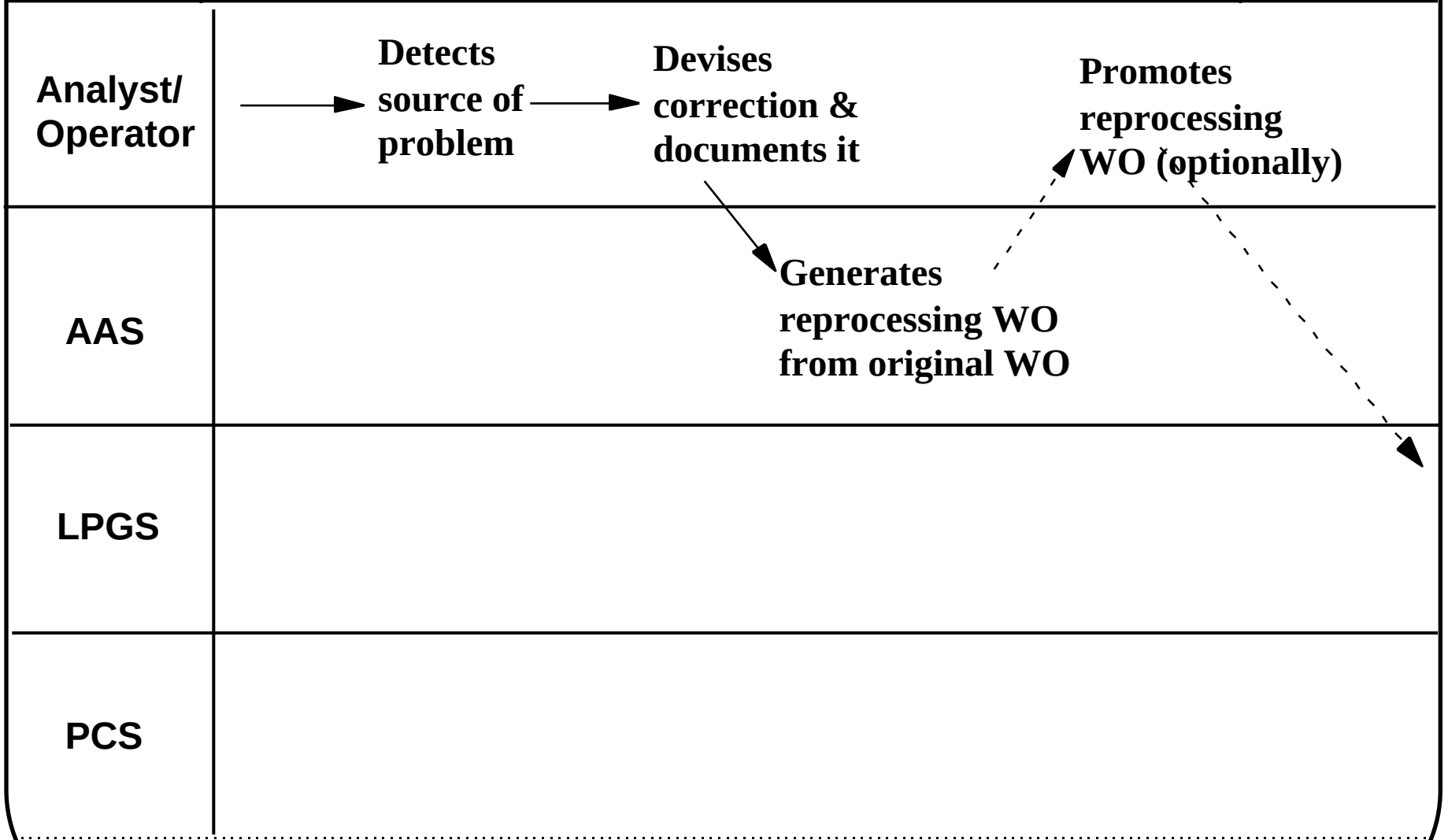
Non-Nominal Processing of L1 Product (4 of 5)



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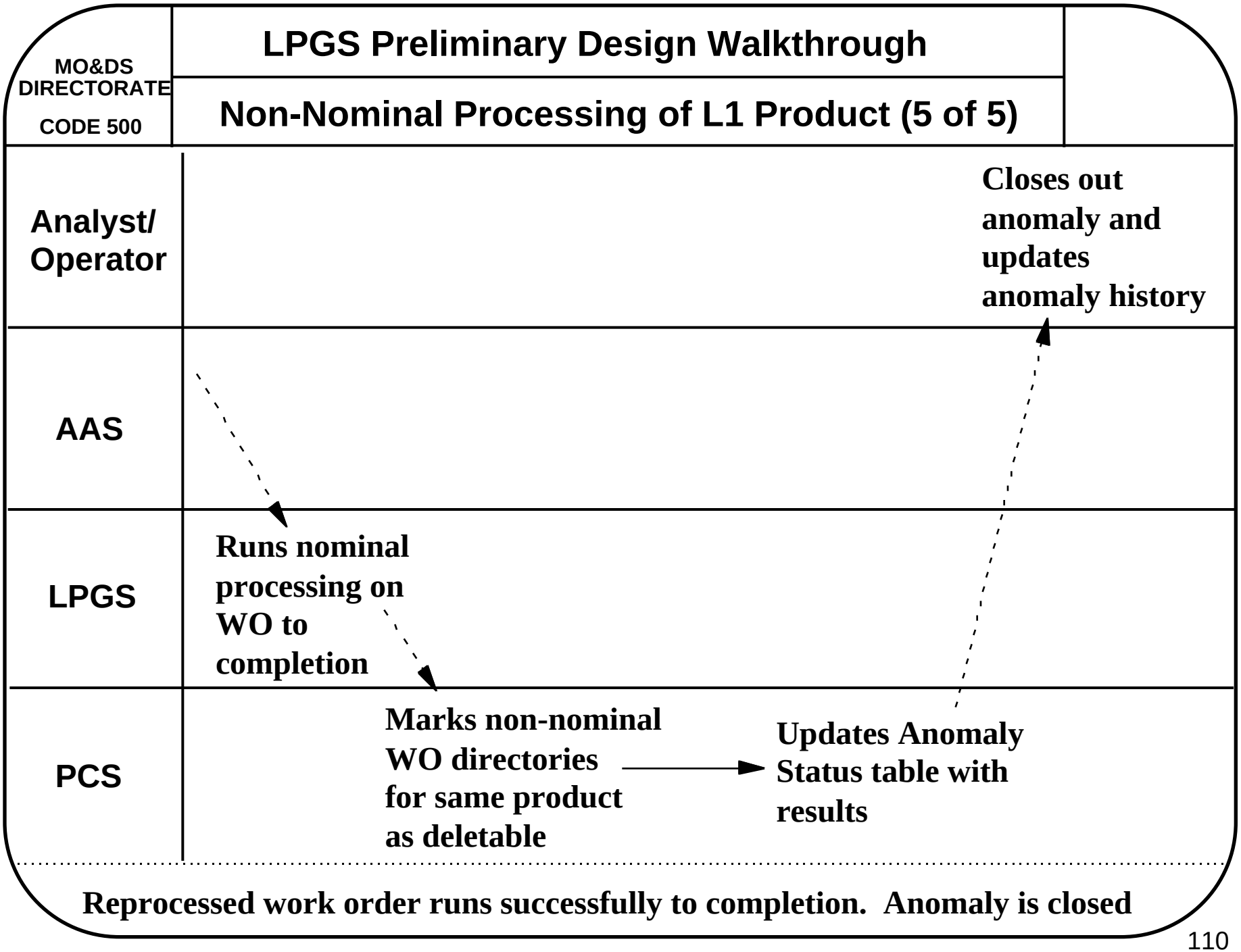
LPGS Preliminary Design Walkthrough

Non-Nominal Processing of L1 Product (5 of 5)



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LPGS Software Size Estimate

LPGS Software Subsystem	Estimated DSI
Process Control Subsystem	10,000
Data Management Subsystem	25,000
Radiometric Processing Subsystem	24,000
Geometric Processing Subsystem	40,000
Quality Assessment Subsystem	2,500
Anomaly Analysis Subsystem	2,500
User Interface	5,000
Database	7,500
Global Routines	2,000
Diagnostic & Test Tools	4,000
Total	122,500

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Issues/Concerns

- **ECS - LPGS interface**
  - **Interface products and protocol must be finalized by April 30 to avoid loss of time to re-work design**
- **Network Connection at EDC DAAC**
  - **where will LPGS be? (answer affects the IAS/LPGS interface. IAS has begun Release 1 and needs this issue resolved)**
- **GeoTIFF file format TBD**
- **Image Expert needed to identify QAS thresholds**

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LPGS Preliminary Design Walkthrough

Agenda

• Opening Comments	R. Schweiss
• System Overview	R. Hamilton
• Operations Concept Overview	A. Bernard
• LPGS Software Subsystem Design	
– Overall Design Philosophy	B. Pedersen
– Process Control Subsystem	B. Pedersen
– Radiometric & Geometric Proc Subsystems	B. Pedersen
– Data Management Subsystem	S. Beckwell
– Quality Assessment Subsystem	S. Kraft
– Anomaly Analysis Subsystem	B. Nair
– End-to-End Scenario	B. Pedersen
• Issues/Concerns	D. Derrick
• Road to CDR	D. Derrick
• Closing Comments	R. Schweiss

LPGS Preliminary Design Walkthrough

Road to CDR

- Complete throughput prototyping
- Procure development and operational hardware systems
- Complete definition of interfaces (internal and external)
- Complete definition of output file formats
- Complete design
  - All structure charts (high and low level are completed)
  - PDL to describe high level units, structured English for remaining units
- Complete refinement of operational scenarios
- Procure COTS packages needed for development
- Generate design level operator/analyst user's guide
- Identify and complete any necessary prototyping, e.g., User/analyst interface
- Develop the detailed LPGS Build/Release Plan
- Develop the LPGS System Integration and Test Plan and identify test data requirements

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LPGS Preliminary Design Walkthrough

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• Closing Comments	R. Schweiss

LPGS Preliminary Design Walkthrough

Closing Comments

Submit Feedback Forms to Bob Hamilton by COB April 25

Robert_Hamilton@cscgt.gsfc.nasa.gov

Mailing Address:

CSC
7700 Hubble Drive
Lanham-Seabrook, Maryland
20706
(Attention: Bob Hamilton)

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LPGS Preliminary Design Walkthrough

Schedule

ID	Name	Scheduled Start	Scheduled Finish
1	Landsat 7 Launch	5/15/98	5/15/98
2	Project Planning	4/29/96	6/15/96
3	Project Plan Review	5/17/96	5/17/96
4	LPGS Requirements Definition	6/17/96	9/30/96
5	LPGS Operations Concept Definiti	6/17/96	12/15/96
6	LPGS System Design	9/2/96	12/15/96
7	System Reqs/System Design Rev	12/15/96	12/15/96
8	LPGS Prelim Design Walk Throug	4/17/97	4/17/97
9	LPGS Design	12/16/96	8/12/97
10	LPGS Critical Design Review	8/12/97	8/12/97
11	LPGS Implementation	8/12/97	7/20/98
12	LPGS Release 1	8/12/97	4/20/98
13	LPGS Release 2	4/20/98	7/20/98
14	LPGS Installation at EDC	7/20/98	8/21/98
15	LPGS Maintenance	4/15/98	9/30/98
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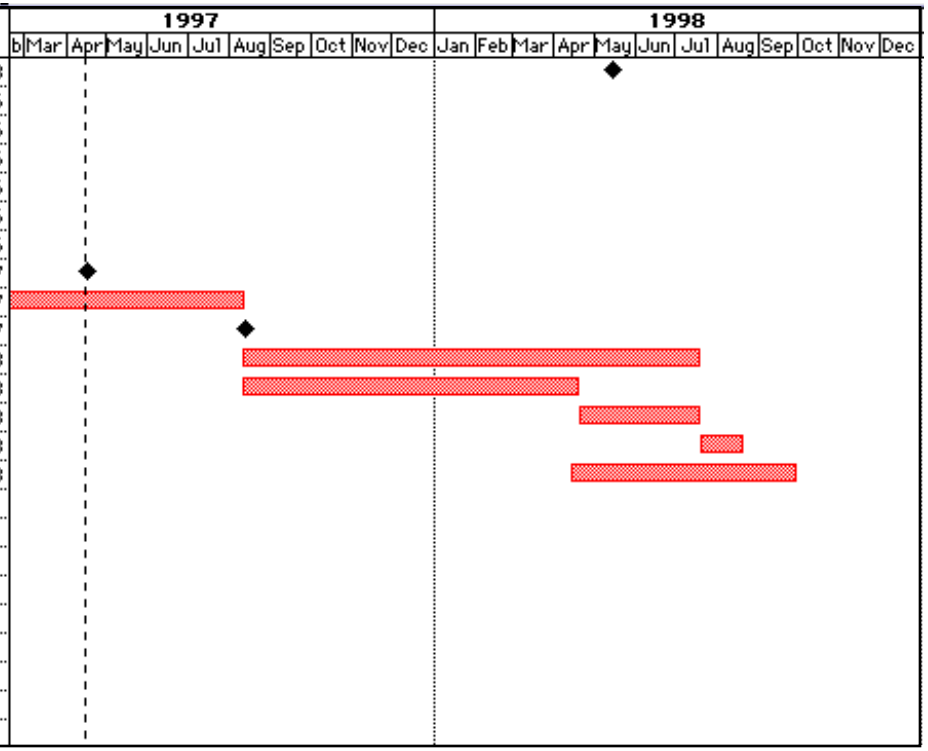

LPGS Preliminary Design Walkthrough

Glossary (1 of 3)

AAS	anomaly analysis subsystem
API	applications programming interface
cNMOS	consolidated Network and Mission Operations Support
CCR	configuration change request
COTS	commercial off-the-shelf
CPF	calibration parameter file
CPU	central processing unit
DAAC	Distributed Active Archive Center
DAT	digital audio tape
DBMS	Database Management System
DD	data dictionary
DDE	data dictionary entry
DFD	data flow diagram
DHF	Data Handling Facility
DMS	Data Management Subsystem
DSS	data server subsystem
ECS	EOSDIS Core System
EDC	EROS Data Center
EGS	EOS Ground System
EOS	Earth Observing System
EOSAT	Earth Observation Satellite Company
EOSDIS	EOS Data and Information System
EROS	Earth Resources Observing System
ESDIS	Earth Science Data and Information System
ETM+	Enhanced Thematic Mapper Plus
F&PRS	functional and performance requirements specification
FAST	an output format for L1 digital images
FDDI	fiber distributed data interface
FIFO	first in, first out
GB	gigabytes
GCP	ground control point
GDS	ground data system
GeoTIFF	an output format for L1 digital images
GPS	Geometric Processing Subsystem
GSFC	Goddard Space Flight Center
GUI	graphical user interface
HDF	hierarchical data format
HWC	hardware component
HWCI	hardware configuration item
I/O	input/output
IAS	Image Assessment System
IC	internal calibrator
ICD	interface control document
IDD	interface data descriptions
IDL	Interactive Development Language

LPGS Preliminary Design Walkthrough

Glossary (2 of 3)

IGS	international ground station
ISO	International Standards Organization
L0R	Level 0R
L1	Level 1
L1G	Level 1G
L1R	Level 1R
Landsat	Land Satellite
LGN	Landsat ground network
LGS	Landsat 7 ground station
LPGS	Level 1 Product Generation System
LPS	Landsat 7 Processing System
M	meter
MB	megabytes
Mbps	megabytes per second
mm	millimeter
MMO	Mission Management Office
MO&DSD	Mission Operations and Data Systems Directorate
MO&SDD	Mission Operations and Systems Development Division
MOC	Mission Operations Center
MSCD	mirror scan correction data
MSS	management subsystem
MTF	modulation transfer function
MTPE	Mission to Planet Earth
MTTR	mean time to restore
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
NFS	Network File System
NOAA	National Oceanic and Atmospheric Administration
PC	personal computer
PCD	payload correction data
PCMB	Project Configuration Management Board
PCS	Process Control Subsystem
PRQ	PCS Request Processor
PSO	Project Science Office
PWC	PCS Work Order Controller
PWG	PCS Work Order Generator
PWS	PCS Work Order Scheduler
QA	quality assessment
QAS	Quality Assessment Subsystem
RAID	redundant array of inexpensive devices
RMA	reliability, maintainability, and availability

LPGS Preliminary Design Walkthrough

Glossary (3 of 3)

- RPC remote procedure call
- RPS Radiometric Processing Subsystem
- RSI Research Systems, Inc.
- RTM Requirements and Traceability Management (tool)
- SAT Shift Along Track
- SDPS science data processing segment
- SDR system design review
- SDS system design specification
- SGI Silicon Graphics, Inc.
- SNR signal-to-noise ratio
- SRR system requirements review
- SSR solid-state recorder
- SWCI software configuration item
- SQL Structured Query Language
- TBD to be determined
- TBR to be resolved
- TBS to be supplied
- TIFF tagged image file format
- UI user interface
- USGS United States Geological Survey
- UTM Universal Transverse Mercator
- WRS Worldwide Reference System